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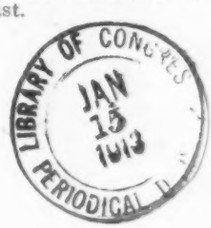

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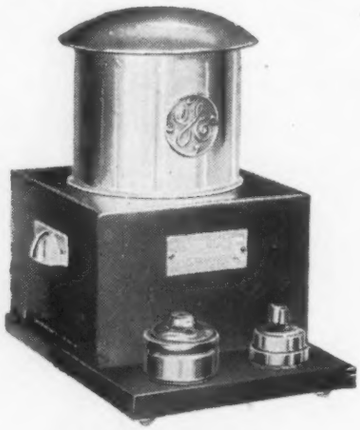

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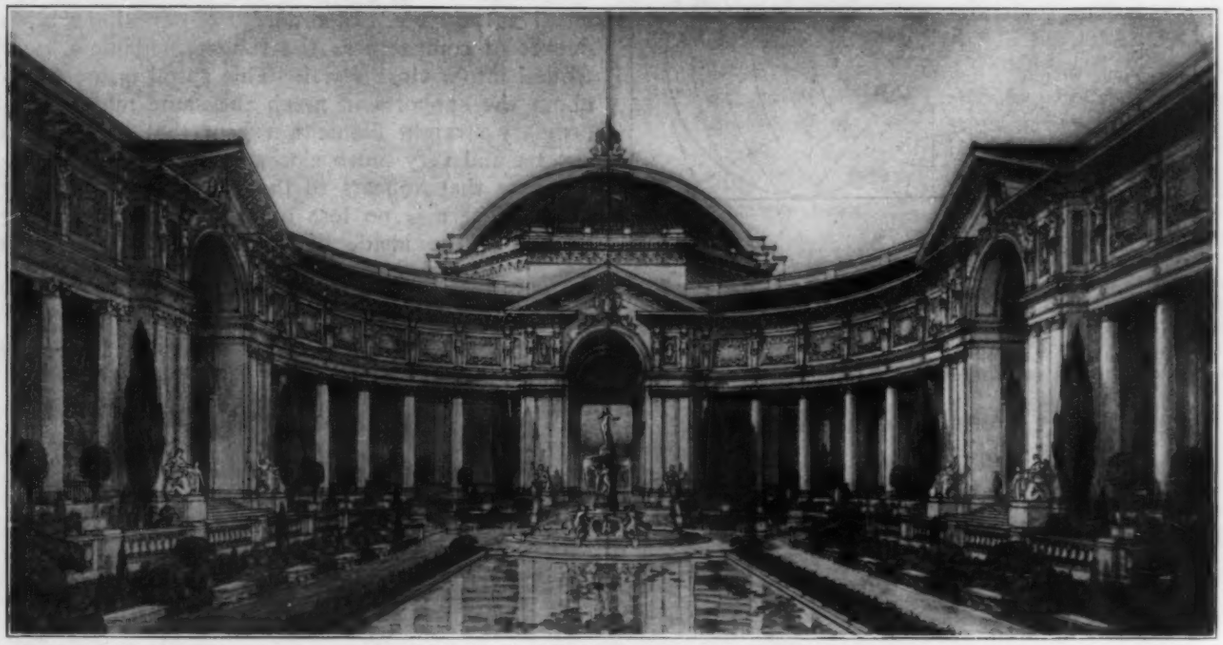


The West Court of The Panama-Pacific Exposition.

ILLUMINATION OF THE PANAMA-PACIFIC EXPOSITION

BY FRANK A. BENFORD, JR.[1]

The problem of illuminating the Panama-Pacific International Exposition is more than the problem of supplying simply the amount of light necessary for seeing purposes. This exposition must be illuminated in a manner that is unique, distinctive, and that will leave a strong impression of individuality upon the visitor. The architect demands that the beauties of his colonnades and towers be brought out as well under artificial light as under daylight. The sculptor is not satisfied with a silhouette at night; his figures must have perspective, form, life. The artist, also, would like to see his great mural paintings appear in their true colors. These, and many other problems, have been solved, and it remains only to work out the details before the Exposition opens in 1915.

Fortunately, the great advances made in illuminating materials and methods during the last few years enable the illuminating engineer to do things that but a short time ago were impossible. Much new material has been developed especially for this exposition, and the work of development is still going on under the direction of Mr. W. D'A. Ryan, Director of the Illuminating Laboratories of the General Electric Company, and recently appointed Chief of Illumination for the Panama-Pacific International Exposition.

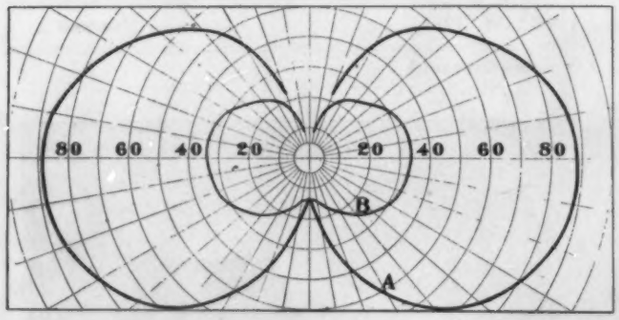
In Fig. 1 are shown the curves and data for the old carbon incandescent and the tungsten filament lamp. Both lamps are rated at 100 watts. The one gives a mean spherical candlepower of 28.1, the other gives 70.3 mean spherical candlepower, or two and one-half times the light for equal amounts of power.

The walls back of the colonnades in some of the courts of the exposition buildings will be covered with large paintings. The method of lighting these paintings by lamps placed in the back of the columns is shown in Fig. 2. Three lamps will be placed in each column at heights of about 10, 20 and 30 feet. The illumination on the paintings can be absolutely controlled in intensity and distribution by changing the size of the units and the curvature of the reflecting surface; and by introducing colored bulbs, any color effect may be obtained. The light from these lamps is

[1]Assistant to W. D'A. Ryan, consulting illuminating engineer for the Panama-Pacific Exposition.

distributed on three principal planes; the ceiling, the wall and the floor. Viewed from the plane of the ceiling or wall they would be seen as direct units, and thus have in this direction the high efficiency characteristic of direct lighting units. Viewed from the floor the two upper lights shown in Fig. 2 would appear as semi-indirect units, while the two lower lights would appear as indirect units; or by properly shaping the recess that contains the lamp, the source of light may be made entirely invisible from the floor, without any sacrifice in efficiency. This type if unit is for use on smooth columns. A special type of tubular lamp has been developed for fluted columns, the lamp and reflector being small enough to go into a flute of the column.

COMPARATIVE DISTRIBUTION CURVES
RELATIVE CANDLE-POWER FOR EQUAL WATTAGE
A-100 WATT MAZDA LAMP
B-100 WATT CARBON FILAMENT LAMP



	A	B
Mean Hemispherical Candle-Power	74	28.3
Watts Per Mean Hemispherical Candle-Power	1.35	3.52
Mean Spherical Candle-Power	70.3	28.1
Watts Per Mean Spherical Candle-Power	1.42	3.56
Downward Lumens	464	178
Total Lumens	883	353
Watts Per Mean Horizontal Candle-Power (Intern'l)	1.13	2.97

Fig. 1. Comparative Data on The Carbon Incandescent and Tungsten Filament Lamps.

DISTRIBUTION OF COLUMN LIGHTS
100 WATT MULTIPLE MAZDA LAMPS
WATTS PER MEAN HOR. C.P. (INTERN'L) CLEAR LAMP 1.13 B.F. LAMP 1.19

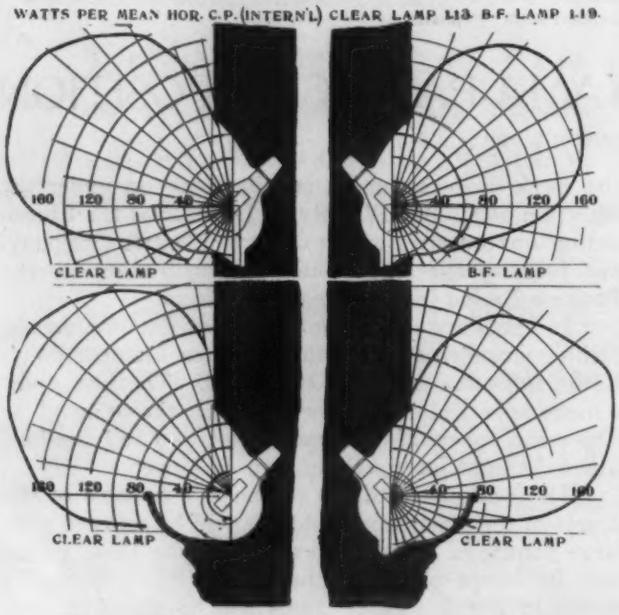


Fig. 2. Method of Lighting Paintings By Lamps Placed in the Back of Columns.

The recent development of the concentrated filament tungsten lamp marks an era in the history of incandescent lamps. A great deal of the development, especially in the larger sizes of lamp, has been carried out with the particular needs of the exposition in view.

In the theory of projectors it is shown that the intensity of a projector beam varies inversely as the square of the diameter of the source. It is thus evident that the diameter of the source should be as small as possible. In order to obtain the necessary degree of compactness the tungsten filament is first wound into a close spiral. This spiral is then looped about the supports in much the same manner as an ordinary straight filament, except that the loops are shorter and very much closer together. The result is a source that appears to the eye to be practically a point. There is no loss of energy due to the light caught in the inside of the spirals, as the energy this light all finally reappears on the outside of the spiral as light.

PROJECTOR FOR PANAMA PACIFIC INTERNATIONAL EXPOSITION

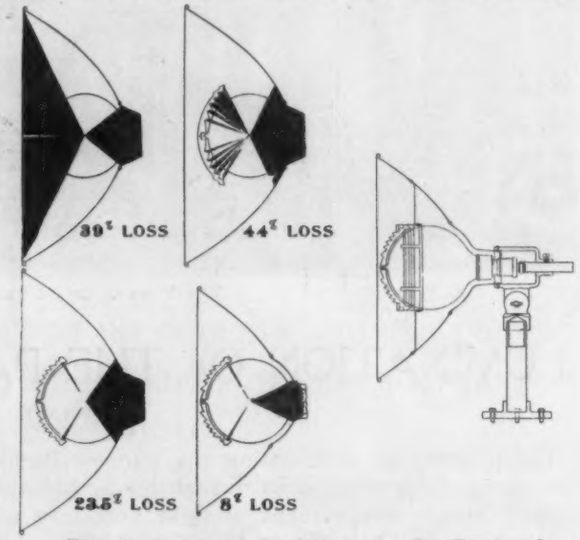


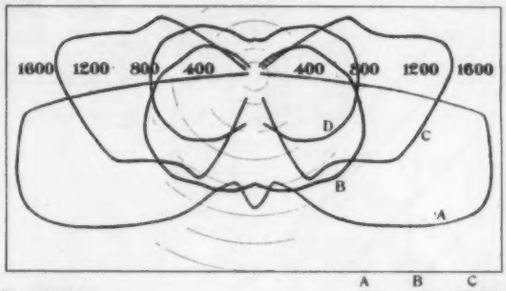
Fig. 3. Improved Projectors to Be Employed.

A study of the uses to which incandescent projectors are to be put in the Panama-Pacific International Exposition brought out strongly the two following points: First, a strong, well-defined beam is needed; and second, stray light from the projector should be eliminated. The method by which both conditions are fulfilled is shown in Fig. 3, which also shows the steps in the development of the projector, and gives the theoretical loss figures. These figures for losses do not include losses due to absorption or dispersion on the reflector, or losses due to dispersion, absorption and reflection at the lens. The actual performance figures will hold about the same relative values as given in Fig. 3, and thus the latter will do for purposes of comparison. In the cuts a vertical section of the lamp, reflector and lens is shown. The

shaded portions represent light that is lost because it is not brought into line with the beam from the projector. An ordinary parabolic reflector is shown in the upper left hand sketch. The light entering the base of the reflector and lamp is of course lost, and that

COMPARATIVE DISTRIBUTION CURVES

A—10 AMP. A.C. SERIES VERTICAL CARBON ENCLOSED FLAME ARC LAMP, FORM W, 60 CYCLES, CLEAR GLOBE
B—10 AMP. A.C. SERIES VERTICAL CARBON ENCLOSED FLAME ARC LAMP, FORM W, 60 CYCLES, ALBA GLOBE
C—6.6 AMP D.C. SERIES ORNAMENTAL LUMINOUS ARC LAMP, CLEAR GLOBE
D—6.6 AMP. D.C. SERIES ORNAMENTAL LUMINOUS ARC LAMP, PHENO GLOBE



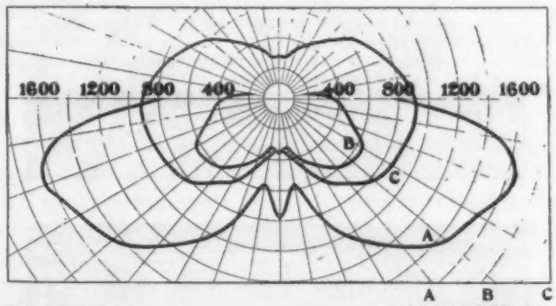
	A	B	C	D
Volts Terminal	60	60	75-80	75-80
Amperes	10	10	6.6	6.6
Watts	455	455	510	510
Mean Hemispherical Candle-Power	1527	850	1040	668
Watts Per Mean Hemispherical Candle-Power	0.30	0.54	0.49	0.76
Mean Spherical Candle-Power	775	609	845	629
Watts Per Mean Spherical Candle-Power	0.59	0.75	0.60	0.81
Downward Lumens	9610	5340	6531	4200
Total Lumens	9730	7650	10610	7920

Fig. 4. Distribution Curves for Various Lamps.

leaving the source within the shaded area in front is scattered. If an attempt is made to retract this scattered light into the beam from the projector by placing a semaphore lens in front of the source (top, right hand figure) the results will confirm the figures given.

COMPARATIVE DISTRIBUTION CURVES

A—6.6 AMP. D.C. SERIES LUMINOUS ARC LAMP FORM 6 MAGNETITE
B—6.6 AMP. D.C. SERIES ENCLOSED CARBON ARC LAMP
C—6.6 AMP. D.C. SERIES ORNAMENTAL LUMINOUS ARC LAMP FORM 10 MAGNETITE



	A	B	C
Volts Terminal	75-80	75-80	75-80
Amperes	6.6	6.6	6.6
Mean Hemispherical Candle-Power	1320	520	795
Watts Per Mean Hemispherical Candle-Power	0.39	1.0	0.64
Mean Spherical Candle-Power	696	301	725
Watts Per Mean Spherical Candle-Power	0.73	1.73	0.70
Total Lumens	8750	3780	9110
Downward Lumens	8300	3200	4993

Fig. 5. Arc Lamps of Equal Wattage Compared.

The beam will be weakened, and the reduction of stray light will be small. Due to certain peculiarities in the design of the ordinary semaphore lens, it scatters about as much light as it concentrates. Also, light that strikes the parabola near the base and is reflected in the line of the beam, is thrown out of parallel by the outer edges of the lens, and is added to the scattered light.

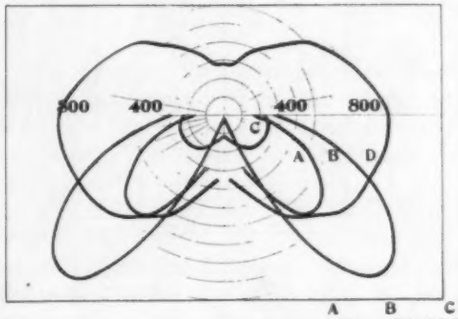
The next step was to design a special lens that would concentrate practically all of the light incident upon it. A section through this lens is shown in the lower left hand figure. There is still some light lost that is incident upon the base of the reflector. To correct this, the base of the reflector was made spherical. All light reflected from this surface strikes the lens at the proper angle to be refracted into the beam. The relative efficiencies of the four projectors, based on the conditions mentioned above, are 100 per cent, 92 per cent, 125 per cent and 151 per cent respectively.

A sketch of the assembled concentrated filament lamp, lens and reflector is shown on the right of Fig. 3.

The distribution curves and data given in Fig. 4 show the advance made in arc lamps from the time of the old 6.6 amp. d.c. series open arc to the present 6.6 amp. d.c. series ornamental luminous arc. The open arc had a maximum intensity at 45 degrees, with but little light directly under the lamp, or on the street and

COMPARATIVE DISTRIBUTION CURVES

A—6.6 AMP. D.C. SERIES OPEN CARBON ARC LAMP
B—9.6 AMP. D.C. SERIES OPEN CARBON ARC LAMP
C—6.6 AMP. A.C. SERIES ENCLOSED CARBON ARC LAMP
D—6.6 AMP. D.C. SERIES ORNAMENTAL LUMINOUS ARC LAMP FORM 10 MAGNETITE



	A	B	C	D
Volts Terminal	50	50	75-80	75-80
Amperes	6.6	9.6	6.6	6.6
Watts	330	480	425	510
Mean Hemispherical Candle-Power	382	736	232	795
Watts Per Mean Hemispherical Candle-Power	0.86	0.65	1.83	0.64
Mean Spherical Candle-Power	243	450	144	725
Watts Per Mean Spherical Candle-Power	1.36	1.07	2.95	0.70
Downward Lumens	2400	4620	1460	4993
Total Lumens	3050	5650	1810	9110

Fig. 6. Enclosed Flame Arcs and Luminous Arcs.

buildings beyond the 45 degrees zone. The type of lamp was superseded by the enclosed arc, having a distribution as shown in Curve C. Although the enclosed arc gave less light than the older arc lamp, on account of its superior distribution it gave better illumination, and had the added advantages of greater steadiness a lower intrinsic brilliancy, and a much longer life. Curve D shows a distribution that is admirably suited for illuminating the exterior of buildings as well as the street. This is the type of lamp that will be used on the exposition grounds. The light is white, and the colors of the buildings will be maintained at the proper values at night as well as during the day. A dense globe will be used and the intrinsic brilliancy of the lamp reduced to the point where it may be looked

at directly without any injurious effects on the eye. This is a very important thing in exposition lighting, for people are constantly looking about, and any exposed brilliant source is sure to lead to headaches and general irritability.

Data for three arc lamps of equal wattage are shown in Fig. 5. "A" is the 6.6 amp. d.c series luminous are lamp so extensively used in street lighting,

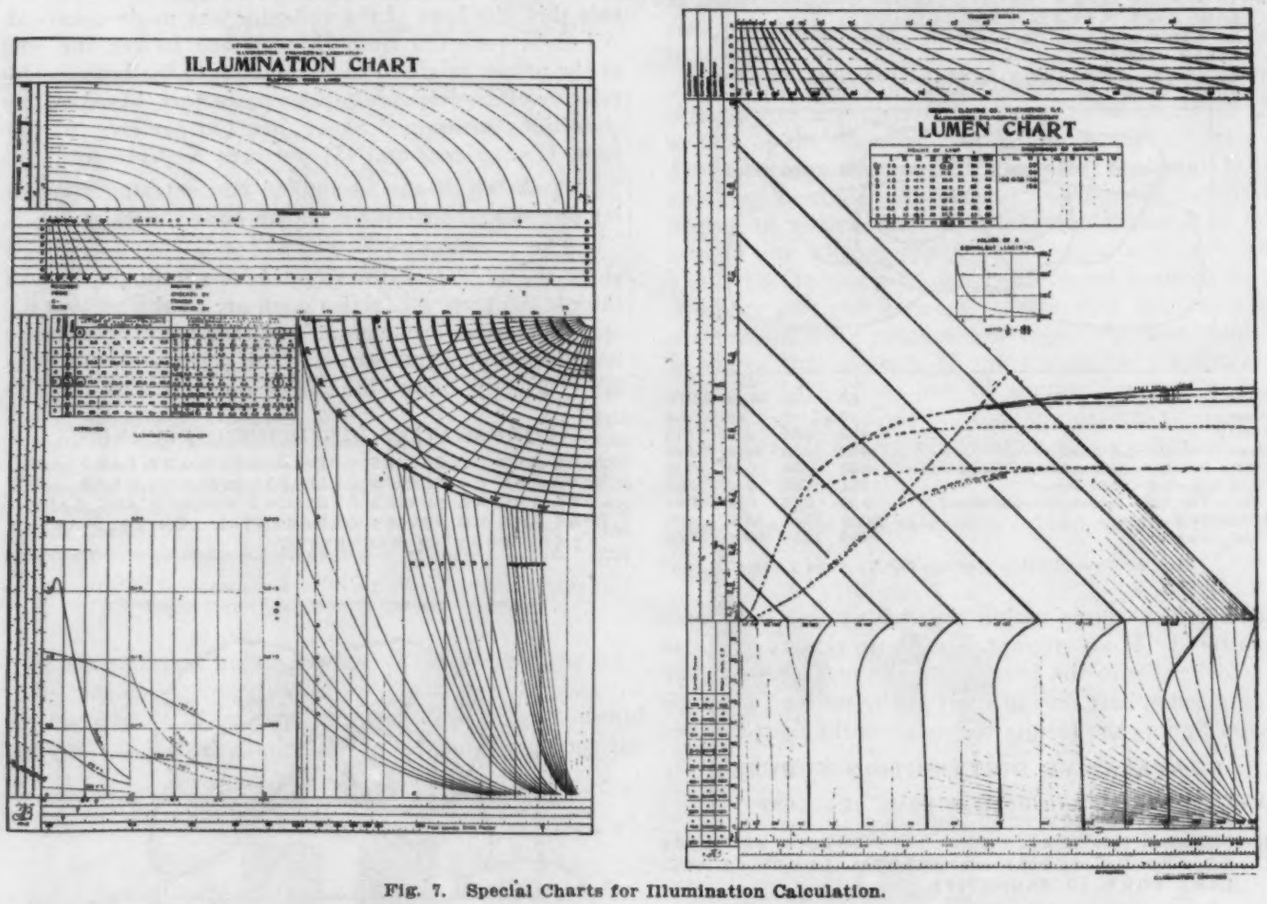


Fig. 7. Special Charts for Illumination Calculation.

"B" is the enclosed carbon arc, and "C" is the ornamental luminous arc.

In Fig. 6 are shown the distribution curves for enclosed flame arcs and luminous arcs with clear and dense globes. The flame lamp has a distribution characteristic (see Curve B) that makes it well suited for lighting large inside areas, and this type of lamp will be used extensively for indoor lighting. At the St. Louis Exposition in 1904 the 6.6 amp. a.c. series enclosed carbon arc, Curve C, Fig. 4, was used extensively. This lamp takes 2.95 watts per mean spherical candlepower. The ornamental luminous and flame lamps with heavy diffusing globes have consumptions of about 0.78 watts per mean spherical candlepower. Thus, this exposition will receive nearly four times the light for an equal amount of power.

In making illumination calculations for the exposition a great deal of special work was encountered. No tabulations of illumination constants or other data are available for much of this work, and direct calculation is almost out of the question. The Illumination Chart[2] was used almost exclusively for the calculations so far carried out, some of which are shown in Figs. 7, 8 and 9. The method of using this chart is purely graphical, and is carried out on a draughting board. On the candlepower web near the middle of the chart is shown a section of the distribution curves of a 6.6 amp. d.c. series ornamental luminous arc lamp with a Pheno globe. The lamp is 15 ft. above the reading plane. In the lower left hand corner are

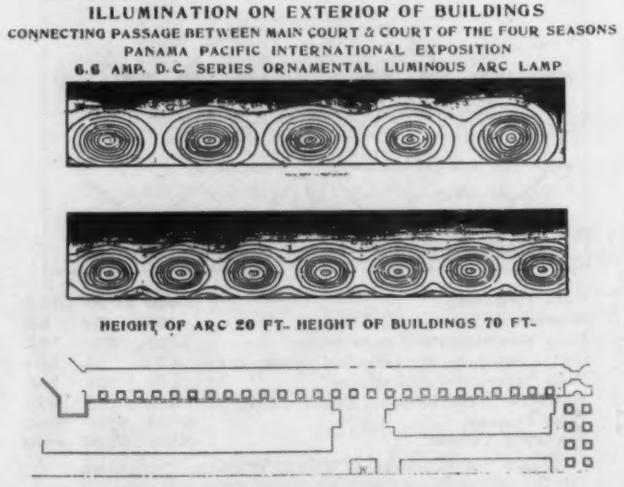

ILLUMINATION ON EXTERIOR OF BUILDINGS
CONNECTING PASSAGE BETWEEN MAIN COURT & COURT OF THE FOUR SEASONS
PANAMA PACIFIC INTERNATIONAL EXPOSITION
6.6 AMP. D.C. SERIES ORNAMENTAL LUMINOUS ARC LAMP
HEIGHT OF ARC 20 FT.- HEIGHT OF BUILDINGS 70 FT.

Fig. 8. Passage Between the Main Court and the Court of Four Seasons.

shown four curves of horizontal illumination along four parallel lines in the reading plane. One line is directly under the lamp, and the other three are at distances from this of 25 ft., 50 ft. and 100 ft. There are more

[2]For a description of the chart see a paper read before the Illuminating Engineering Society, Niagara Falls, Ont., Sept. 16-19, 1912.

than 40 distinct kinds of illumination curves that may be calculated on this chart.

On the right of Fig. 7 is given a reproduction of a Lumen Chart. This chart is used for calculating the total lumens that fall within any given area. By means of this chart the figure for lumens per square foot, and several other similar figures may be readily obtained for any given case.

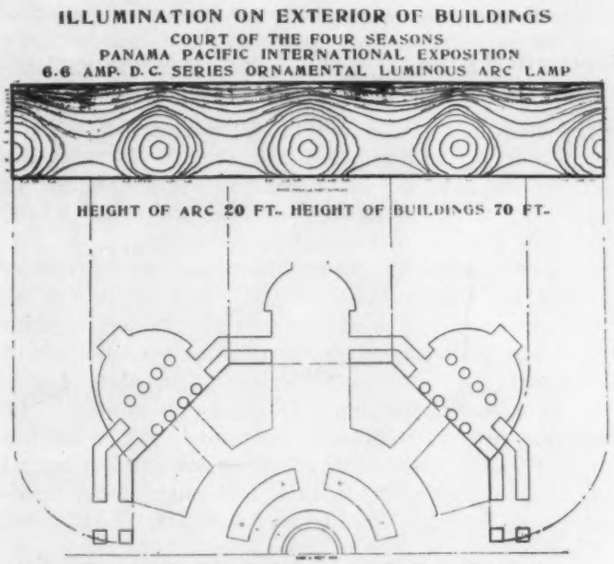

ILLUMINATION ON EXTERIOR OF BUILDINGS
COURT OF THE FOUR SEASONS
PANAMA PACIFIC INTERNATIONAL EXPOSITION
6.6 AMP. D.C. SERIES ORNAMENTAL LUMINOUS ARC LAMP
HEIGHT OF ARC 20 FT.- HEIGHT OF BUILDINGS 70 FT.-

Fig. 9. Walls of the Court of Four Seasons.

At the bottom of Fig. 8 is shown a half plan of the connecting passage between the main court and the court of the four seasons. Two spacings of lamps are shown, one for seven lamps on a side, and the other for five on a side. Above the plan are the corresponding isolux diagrams for the illumination on the walls of the buildings. The lamp used in this and the following isolux diagrams is the 6.6 amp. d.c. series ornamental luminous arc lamp with a Pheno globe. In the original drawing these diagrams are accurately shaded to show the relative illumination on the different parts of the building. In the process of reproducing these diagrams the shading is distorted and the difference between the light and dark parts greatly exaggerated. The proper shading is obtained very accurately by comparing it with a strip of the same paper that has been shaded from pure white to jet black and then calibrated in a photometer. Under even illumination these diagrams give a very good idea of the actual results obtained in practice.

The illumination on the walls of the court of the four seasons is shown in Fig. 9. There are eight standards arranged in a circle around the center of the court, and the calculations were made for one lamp per standard. The number of lamps that will actually be used may be anywhere from one to ten. If more than one lamp per standard is used the resultant illumination may of course be obtained by multiplying all the foot-candle figures by the proper factor.

The main court of the exposition is to be illuminated by the light from two large fountains on the main axis of the court. These fountains will be constructed of dense white glass, and in the daytime will in no wise suggest light sources. Within each fountain there will be 72 arcs, a total of 144 for the court. When these arcs are lighted at night the entire surface of the fountain will become luminous, flooding the court with a softly diffused light. In Fig. 10 is shown a plan of one quarter of the court, and above it a development of the walls about the court with isolux lines showing the illumination from the two central foun-

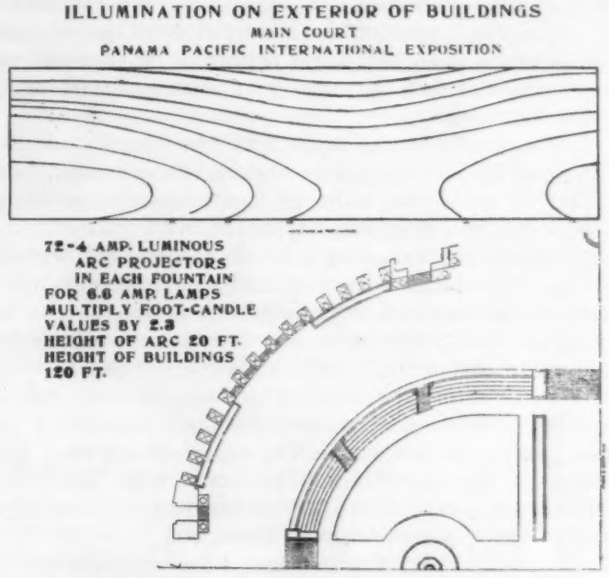

ILLUMINATION ON EXTERIOR OF BUILDINGS
MAIN COURT
PANAMA PACIFIC INTERNATIONAL EXPOSITION
72-4 AMP. LUMINOUS ARC PROJECTORS IN EACH FOUNTAIN
FOR 6.6 AMP. LAMPS MULTIPLY FOOT-CANDLE VALUES BY 2.3
HEIGHT OF ARC 20 FT.
HEIGHT OF BUILDINGS 120 FT.

Fig. 10. Illumination Main Court Panama-Pacific Exposition.

tains. In the diagram the illumination is calculated up to a point about twice the height of the buildings. This was done to include several towers and arches that extend above the general building line.

SWISS USE OF GAS FOR COOKING.

The use of gas for cooking in Switzerland is very extensive and is on the increase. In 1893 there were 3714 gas meters in the city of Zurich, 87 per cent of which measured gas used for lighting and 13 per cent for technical, cooking, and heating purposes. In 1910 the number of consumers had increased to 47,376, and only 26 per cent used gas for lighting, while 73 per cent of the total number were consumers of gas as fuel for cooking and heating, and the remaining 332 meters registered the amount of gas consumed for technical uses and gas motors. Corresponding increases have taken place in other large cities of the Confederation.

These conditions have made the manufacture of gas cooking stoves and apparatus an enterprise of much promise. There are now four or five plants of this sort in Switzerland (the largest being the Schweizerische Gasapparaten Fabrik at Solothurn), which not only supply much of the domestic demand for such articles but also export considerable quantities to South America and other countries. The value of the exports of stoves and ovens in 1911 was $74,719, of which about one-third was gas stoves, exported chiefly to Argentina, Italy, Brazil and Chile. It is estimated that the value of the product of the Swiss manufactories of gas cooking apparatus is between $150,000 and $175,000 annually.

ARTIFICIAL TRANSMISSION LINES[1]

BY H. F. FISCHER.

The phenomena which are now becoming of the very greatest importance to the electrical engineer, due to the dependence thereon of further advances in the art, are those transient phenomena of waves, impulses, surges, etc.

The conditions of the steady flow of power are fairly well known today and results to be expected in any particular case can usually be predetermined more or less accurately.

The limitations of apparatus are not always determined by the normal conditions of operation, but rather by abnormal, although not unusual, operating conditions, and it is easily apparent, with greater concentration of power, longer transmissions and higher voltage apparatus that the study of transient phenomena becomes of increasing importance, and it is therefore not surprising to observe the active interest shown of late in the design, construction and testing of various artificial transmission lines.

By artificial transmission lines (as considered in this paper) are not meant the experimental lines for the study of high voltages, but rather what might be termed sluggish or slow speed conductors for the study of transient phenomena, regulation, etc.

Such artificial transmission lines are not alone interesting theoretically, but have in one instance at least very direct practical application. The speaker has in mind a case where the entire transmission system of a power company has been faithfully duplicated in their laboratory, for the sole purpose of developing and trying out various relays, etc., with the idea of eliminating destructive influences under various conditions of operation and thus insuring, to the highest possible degree, continuity of service.

In long transmission lines, the consideration of line resistance and line reactance is by no means sufficient to explain actual line phenomena, but we must include the consideration of distributed line capacity and line leakage.

The general case of a long distance transmission may be then attacked if we consider the circuit as having four line constants, (mere physical constants theoretically independent of frequency or voltage) which are

r = resistance per unit length.
g = leakage conductance per unit length.
L = self induction per unit length.
C = electrostatic capacity per unit length.

Furthermore, we know by experiment that the velocity of an electrical impulse over a conductor is approximately equal to that of light or very nearly 186,000 miles a second. Considering, for a moment an open circuited transmission line, an impulse starting from the generator end would travel approximately at the velocity of light, to the open end of the line and be reflected back toward the generator at the same velocity. Should a second impulse be sent out by the generator at the instant that the reflected wave reaches the generator, the two impulses would be added together and we would have the case of a gradually increasing impulse, building up with each second reflection. Such a condition is called resonance and it is readily seen that for an alternating current circuit open at the far end the resonant frequency would be expressed by the relation $f^0 = \frac{S}{4L}$ where S = velocity of light and L = length of transmission.

Assuming an impressed frequency of 60 cycles, the line would have to be approximately 780 miles in length in order to have a natural frequency of 60 cycles or contain one complete wave length.

It is therefore apparent that even the longest of present day transmission lines is but a fraction of an electrical wave length of commercial frequency. Conversely, any transmission circuit may have its length expressed as a function of the impressed wave length. The equation expressing this condition contains the four line constants already mentioned, and in such a form as to indicate that any duplication of the original line must have the same total resistance, total reactance, total leakage conductance and total distributed capacity.

The ideal artificial transmission line would then be a built up electric circuit, so designed as to represent an actual or proposed line for the transmission of electric energy either for power, telephonic or telegraphic application, and having total resistance, total inductance, total distributed capacity, and total leakage conductance as possessed by the line to be duplicated.

Practically, it is impossible to represent a line of any considerable length by means of a single continuous coil or circuit, but artificial line units may be built, each unit or section possessing the four line constants in the same ratio as in the actual line to be duplicated, and then employing a sufficient number of these artificial units to make up or equal the total value of the line constants to be duplicated. In building artificial transmission line units then, the ratio between the line constants must be preserved, irrespective of their magnitude.

The next consideration then is, what voltage and power shall be used on the artificial transmission line, it being entirely out of the question to actually use more than a fraction of the voltage and power transmitted on the line to be duplicated, if it be a power transmission.

The limiting operating conditions for the artificial transmission line are usually the voltage to be handled or the available output from a laboratory generator. Assuming the former to be the case, it is a simple matter to calculate the percentage resistance drop for the actual line and then apply the same percentage resistance drop to the artificial line voltage.

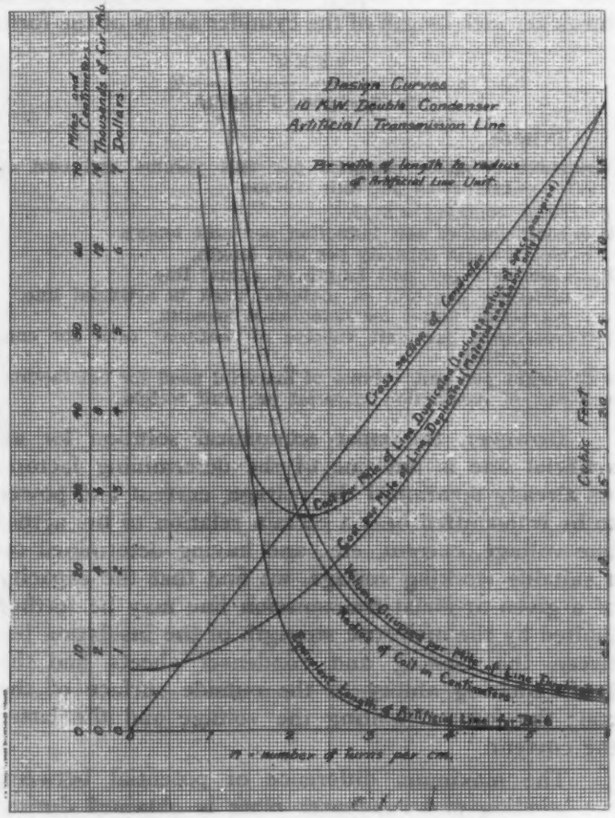
Since the total resistance on both the actual and the artificial line is the same, it is immediately apparent that the current to be transmitted over the arti-

[1]Read before the San Francisco Section, A. I. E. E., Nov. 29, 1912.

ficial line bears the same relation to the current in the actual line as does the voltage in the artificial line compared to the voltage in the actual line.

From the preceding, it follows immediately that the power to be transmitted over the artificial line varies as the square of the voltage ratios.

Having fixed these ratios, it will be found that the same relations will hold for the inductive, capacity and leakage effects, and the artificial transmission line will when so designed give results which are directly proportional to those in the actual line.



Design Curves for Artificial Transmission Lines.

There are two general methods of constructing artificial transmission lines, namely either as "lumpy lines" or as "smooth lines," these expressions being ascribed to Dr. Kennelly.

In general the distinction between these lines is as follows:

In "lumpy lines" the total line resistance, reactance, capacity, etc., is made up of impedance units or coils in series and small condensers shunted across the line at close intervals to represent line capacity.

"Smooth lines" are so constructed that a perfectly even distribution of capacity, resistance and inductance is obtained by wrapping the wire representing the actual transmission line over or between layers of tinfoil or other material suitable for giving distributed capacity effect.

"Lumpy lines" are by far the easiest and cheapest to construct but their usefulness is confined largely to problems in line regulation and other steady energy flow problems, etc., and not to the study of transient phenomena.

"Smooth lines" on the other hand, are considerably more expensive and more difficult to construct, but the even distribution of capacity makes it possible to study under actual line conditions, and without correction factors, all forms of transient phenomena and in addition all regulation phenomena.

An excellent description of a "lumpy line" as constructed and permanently installed in the Graduate School of Applied Science at Harvard, is contained in a paper by A. E. Kennelly and F. W. Lieberknecht, presented before the last annual convention of the Institute at Boston.

In general "lumpy lines" may be classified under two heads, namely "T" lines or π lines, the only difference between the two types being in the distribution of their terminal elements.

In the "T" design, the transmission line would be built of series impedance units, each with one middle tap to which the shunt condenser is attached.

In the π line the same series impedance and shunt condenser units would be used, with the exception that the condensers would tap in between successive series impedances.

As actually constructed, each series impedance in the Harvard line, representing approximately 50 miles (49.7 mi. or 80 km.) of line, consists of four-sided wooden frame, approximately 14 in. over the outside corners, with free winding space along each leg approximately 8 in. long and perhaps $\frac{3}{8}$ in. deep. Each limb of the frame is wound with 1190 turns of No. 19 A.W.G. wire. The object in view when building the impedance models in the form of a four-sided frame was to obtain as nearly as may be a closed magnetic circuit, thus increasing the effective self inductance of each frame and diminishing the external stray magnetic field as far as was conveniently practicable.

The condensers were built of tinfoil and paraffined paper, each condenser unit being enclosed in a tinned box filled with paraffine.

The impedance frames are assembled at right angles to each other so as to reduce their mutual inductance to a minimum, the connections between successive line units being made by means of contact plugs. In this manner the transmission line can be opened at any convenient point and by means of a split plug voltage and current readings are obtained at any time.

The artificial line is notable because of its length, there being sufficient impedance units and condensers available to imitate approximately 500 miles of three phase, star connected line or nearly 1500 miles of single-phase line. The tests outlined in the above mentioned paper were made on approximately 645 miles of this line and as such stand by themselves as the only tests on record over artificial lines of anything like this length.

As far as the writer can observe no startling results have been obtained on this line, all the recorded measurements and observations checking the hyperbolic function theory of such lines within the limits of precision of the measuring instruments.

The second or "smooth type" of line has been described in a paper by J. H. Cunningham, presented before the midyear convention of the Institute in February, 1911.

This line has been designed, built and tested in the Electrical Laboratory of Union College, Schenectady, New York, and differs materially from the one already described.

After consideration of various methods, the type of construction finally adopted was to wind suitably sized wire over hollow glass cylinders approximately six inches in diameter, ⅛ in. thick and 4½ ft. long, each cylinder containing 240 turns of No. 8 B.&S. gauge copper wire. The tubes when finished were assembled in racks of ten rows with ten tubes per row.

In order to obtain distributed capacity, the inside surface of the glass tubes was coated with much difficulty with a layer of tinfoil, held in place by fiber strips and phosphor bronze expansion rings. It seems that great care had to be taken in building these line units since even the phosphor bronze expansion rings were liable to crack the glass cylinders.

As finally completed each unit of this artificial transmission line represents approximately .325 miles of an actual line built with No. 1 B.&S. gauge copper wire, having a spacing of 5 ft. between wires; the total equipment of 400 tubes being equal to approximately 130 miles of such construction.

Such a line, in spite of the increased cost of construction and greater mechanical difficulties, gives an ideal duplication of actual line relations and for certain phenomena is the only type that can be successfully utilized, and it is this type of line that is proposed for experimental research at the University of California.

The mechanical construction however will be slightly different and the final design investigated will permit of some degree of flexibility not inherent in the two artificial lines already described.

A rather complete investigation of the principles of artificial transmission line construction was made a year ago by Mr. F. E. Pernot as a thesis in partial fulfillment of the Master's Degree at the University of California, and it will be largely from Mr. Pernot's paper that data for the proposed type of construction is obtained.

Instead of using fragile glass cylinders, it is proposed to build hollow cylinders of well seasoned wood, suitably treated and wind thereon a layer of fairly heavy tinfoil. This tinfoil layer will be slit longitudinally to prevent its acting as a short circuited transformer turn, and in addition will be slit part way around the circumference, at intervals of a few inches, to reduce eddy currents.

Over this layer of tinfoil will be wrapped a sufficient thickness of insulating material (it has been proposed to use something similar to varnished cambric or treated cloth) and then wind the required number of turns of copper ribbon over this in order to provide sufficient line inductance.

Now, if it is desired to obtain an artificial unit of different line constants it is only necessary to wrap the necessary amount of insulating material over the first winding layer and place another layer of tinfoil over this, thus doubling the capacity without affecting the inductance. This might be carried out further by providing additional layers of coil winding, etc., but for the present only the single and double condenser sheet artificial transmission line units have been considered.

In order to improve the mechanical construction and use the surface of the wire most effectively for capacity effect, all consideration of round wire has been omitted and only flat copper ribbon of suitable dimensions will be used.

As in the case of almost every engineering problem there is a most economical solution, nor has this point been overlooked in the design of the proposed line. The most convenient equation for the economical solution is an expression for n = the number of turns per inch length of the cylinder and is of the form

$$n = \frac{v F R k^2}{2c\ (2\pi)^2\ p\ w\ q\ J\ (9d)^2 10}\ ^{1/4}$$

Where

v = value of space occupied per unit volume and cost of construction per unit volume.
F = some constant = M/J.
M = coefficient of self induction per unit length.
J = electrostatic capacity per unit length.
R = resistance per unit length of actual line.
k = dielectric constant of material used in artificial line.
c = correction factor for inductance formula.
p = resistance per unit volume of material used for conduction.
w = weight per unit volume of material used for conduction.
q = cost of conduction material per unit weight.

However, the most economical solution for an artificial line is but one of the determining factors. As already mentioned the voltage, current and power to be transmitted bear a certain relation to the actual line voltage, current, etc., and having determined on a suitable working voltage, we find that the capacity of a given artificial transmission line may be further limited by the dielectric strength of the insulation between the winding and condenser sheets and the heat radiating ability of the outside surface of the coil; the former limiting the voltage and the latter the current.

The maximum difference of potential between the winding and condenser plate is obtained during the occurrence of a surge in the line due to sudden changes in circuit or load conditions. For the proposed line this has been taken as approximately twelve times the normal operating voltage.

Furthermore, for mechanical reasons a ratio of coil length to coil radius of 6 has been chosen as being suitable.

It may be of interest to see how an artificial transmission line of 10 k.v.a. capacity to duplicate a 250 mile transmission of 6 cables with 10 ft. spacing between wires will work out.

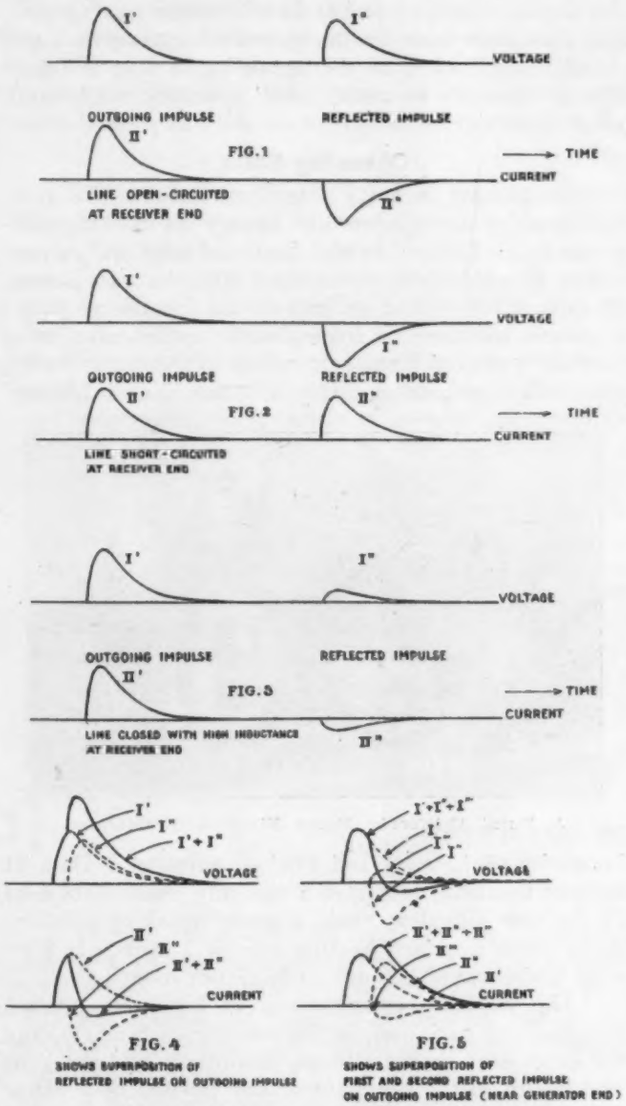
Representative line, 140,000 volts.
250 miles. Six cables. Ten-foot spacing between wires.
Six strands No. 7 copper per cable. 124,920 circular mils.
Resistance per mile = R = 0.4317 ohms.
M = inductance to neutral per wire = 0.00211 henrys.
J = capacity to neutral per wire = 0.0141 micro-farads,
At 81,000 volts to neutral at receiver, a load of 60,000 kw. for the six cables = 10,000 kw. per cable.
At 25 cycles, regulation = 24 per cent.
At 60 cycles, regulation = 34.5 per cent.
For 10 kw. on artificial line

$$E' = \left(\frac{10}{10{,}000}\right)^{1/2} \times 81{,}000 = 2{,}560 \text{ volts.}$$

$$I' = \frac{10{,}000}{0.95 \times 2.560} = 4.12 \text{ amperes.}$$

Before closing it may be of interest to discuss some of the results actually obtained in tests on the smooth artificial transmission line at Union College, New York, with particular reference to the propagation of impulse.

In general it may be stated that an electromagnetic wave or impulse is an energy manifestation; the energy appearing in two forms; that of the dielectric or electrostatic field proportional to the potential difference and that of the magnetic field proportional to the current. Through these two components, viz., voltage and current, it is possible for us to make complete oscillographic studies of such electric impulses.



Varying Impulse Curves in Transmission Phenomena.

It is furthermore true that conversion from one form of energy to the other form may take place under proper conditions; that is to say, the magnetic field energy may be converted to electric energy and vice versa. This is the true fundamental phenomena underlying the following discussion, but for simplicity the intermediate process of conversion taking place during reflection is omitted and the original and reflected components are assumed as following one another directly.

Consider for a moment a transmission system open circuited at the receiver end. We find that an impulse impressed at the generator end will travel toward the receiver, very nearly at the velocity of light (were it not for the inductance and capacity the velocity would be that of light), but having arrived at the far end of the line it will not remain there if it can find a possible outlet. Obviously no other outlet exists except via the route it came by and the observed effect then is that the current component in order to return must reverse in direction and on the oscillographic record the reflected current wave actually appears so. On the other hand, the component wave proportional to the potential difference, is observed to be unaffected by the open circuit and the reflected potential wave appears to be of the same characteristic shape, polarity, etc., as the outgoing potential wave. If the line experimented upon were infinite in length, the wave would travel out over it until all its energy is dissipated whereupon it would vanish. With a line of finite length, the energy wave is reflected back and forth from end to end until all of its energy is dissipated and the impulse vanishes. Assuming a line sufficiently long that the original impulse will not be affected by the reflected impulse, the conditions for an open circuited line would be similar to Fig. 1.

If we consider the case of a transmission line short circuited at the receiver end, we find as before that the energy impulse having arrived at the far end will not remain there if it can find a possible outlet. In this case the current component will not reverse in direction, but will merely travel onward over the return conductor after reaching the short circuit. The component proportional to the potential difference however upon reaching the short circuited end is reflected reversed and appears as such on the oscillographic record as shown in Fig. 2.

With a condition intermediate to the two already described, that is, a line neither open circuited or short circuited, but having some form of resistance inductance or even another transmission system of different line constants connected across the receiver end, we find conditions of reflection intermediate to thos named. For instance a high inductance shunted across the receiver end of the line would act more like an open circuit and it would be found that the greater proportion of the current component is reversed and reflected, only part of it passing back on the return conductor through the inductance. The greater proportion of the voltage component is unaffected as though the line were open, only a part being reflected reversed due to the short effect of the inductance. This is plainly indicated in Fig. 3.

We find that for lines of ordinary length the outgoing impulse has no time to die away before the reflected wave is superimposed on it and as a consequence we obtain oscillograms such as shown in Fig. 4 and 5.

The excellent paper by J. H. Cunningham and C. M. Davis in the May, 1912, proceedings of the A.I.E.E. discusses this phenomena very fully besides illustrating it with observed oscillographic records.

READINESS TO SERVE METHODS

MODERNIZING THE HOUSE.

BY R. B. MATEER.

Only a few years ago many square miles of land covered with sage, or known as desert, were to be found in the West, unproductive and unsought, as agriculture was not deemed the road to great wealth. Here and there a rough redwood shack stood as the mute evidence of an effort to secure something for almost nothing. Many a wandering farmer, finding himself isolated in an unknown land, had relinquished his partially purhased property and sought other labor, where a daily wage was direct return for time served.

Yet from the East came a few settlers possessed of those qualities which today have made the great empire of the Pacific Coast. They secured a title to the land, and, true to their ideals, toiled long, forcing from the earth a livelihood. The shack, with its one room and hard earthen floor, gave place to the comfortable cottage, and later to the large house, the center of all activity on the ranch, which now occupies a commanding position on the once desert waste.

Thrift resulted in structures of imposing exteriors; comfort demanded the use of modern conveniences within. The shack was usually equipped with a few bunks and a stove adapted only to the burning of wood. The candle provided the necessary illumination. In the cottage a base burner gave warmth, the coal range the heat for cooking, the oil lamp the light, all of which were at first in evidence in the larger home.

Convenience demanded other means of illumination, and the gasoline lighting system was installed for both light and fuel purposes. Yet as the oil lamp gave way to better general illumination and the coal stove to convenient fuel-consuming appliances, so those of gas must now yield to the improved "snap of a switch" type.

The old-fashioned stove has been superseded by the efficient and convenient electric range, with the ease and simplicity of heat control. The 40-gallon tank is now heated with a three kilowatt electric water heater, arranged with a thermostatic cut-out, supplying at all times in quantities large or small and at a uniform temperature.

A power table, equipped with an adjustable coffee mill, dough and cake mixer, meat grinder and cream freezer, the mechanic of the kitchen does the work of several pair of hands at a minimum of expense. Panel outlets equipped with push-prong jacks for small table appliances complete the equipment of the kitchen. In the basement is found the labor-saving electric washing machine, and the motor-operated, electrically heated mangle, with several irons, varying from 5 to 7 pounds, for pressing purposes.

Complete so far as laundry and kitchen, yet continuing our tour of inspection, we find the dining room equipped with baseboard and floor receptacles arranged for the use of any one or all of the several appliances, the percolator, toaster, grill and chafer, which are seen to occupy important places on the buffet.

In the living room and library ample provision is found for portable luminous heaters and numerous reading lamps. The bath and chambers are equipped for the use of heater, pad and night lamp.

Complete from the viewpoint of convenience and comfort, but what of the operating cost? What of the investment necessary that a family may enjoy electric service?

Operating Costs.

Some tests recently completed indicate the average monthly consumption of energy for cooking purposes to be 120 kw. in the family of four or five persons. A washing machine used eight hours a month consumes 2 kw., and an iron in use for twelve hours a month will require 6 kw., while a like amount of current is needed for the operation of the mangle each thirty days, a total monthly consumption of 134 kw.

A Rural California Home Electrically Equipped

hours for all laundry and kitchen purposes. Data at present available indicates a monthly consumption of 75 kw. per 40-gallon tank, a grand total of 209 kw., which, at a standard heating rate of 3 cents per kilowatt hour, would amount to $6.27 per month.

The monthly consumption of luminous heaters is subject to variation, as the number of hours' usage are dependent on the climatic conditions and the general health of the occupant of any portion of a house heated electrically. It is, however, safe to figure that the average heater will continue in use each day of the cool months for a period of three hours, or monthly some ninety hours. Where the lamps used are of 250 kw. a maximum monthly consumption of 45 kw. hours per heater can be added to our total.

Convenience dictates at least two such heaters for each country home.

The toaster, the percolator and other appliances used on the table total 30 kw. per month, a grand total of 429 kw. for domestic and heating purposes, or $12.87 per month for heat, when and where desired, and in such quantities without waste as to indicate a high efficiency.

The illumination of the house with tungsten lamps arranged to secure a maximum of light without sacrificing the aesthetic taste of the occupant is accomplished on a consumption of 40 to 50 kw. hours per month, including such current as is desired for the lighting of the porch, an expense varying from $2.80 to $3.50. Light and heat for all household purposes at an average monthly expense of $15.67.

Compare, if you please, the cost of the clean, wholesome electric service with a similar service obtained by the use of coal or wood and their accompanying dirt, or with oil fuels and the constant increase in unit cost, and convincing proof is easily secured, blazing the path of progress to that fuel obtained by the use of "white coal," the gift of nature, and found in such large quantities on our mountain slopes.

Investment.

The equipping of the kitchen, laundry, dining room and chambers with current-consuming appliances means an investment of from $275 to $350, the price the farmer is willing to pay that his home may possess every comfort and convenience. His thrift built the castle, and the appointments within must equal, and many times surpass, the pleasing exterior. While his policy is to secure that which is the most economical and serviceable, his investment in electrical appliances becomes an asset, recognized as such by his neighbors as well as the assessor.

That which possesses value is sought, and the first cost is only considered on a basis of value received. The old coal range, merely a combination of cast iron, is worth but little after delivery to the purchaser, while the electric stove commands its price after much usage. Depreciation is less of a factor in electric current-consuming apparatus than in the older forms of reputed household comforts.

Facts.

It should be remembered that electric appliances have now reached a stage closely approaching perfection, and that the lack of durability, the slowness in heating, and the current consumption complained of a few years ago were no more serious than the faults found with the early coal range; and that as practical applications soon remedied the faults, so today has the early imperfection of the current-consuming appliance been overcome—to such an extent that in one city 40 complete equipments are in use; in another 115, and in a third over 300, and that with the eagerness of the farmer to possess all that may be found in a city home, combined with his known ability to assimilate readily all expense connected with the installation of electrical apparatus such as tends to modernism, the time is not far off when every country home will be equipped as the one briefly mentioned, and yield to the utility that is ready to serve "juice" a handsome return accruing from a load of such character as to be eminently desirable.

More and more it is evident that the expense of educating the urban resident to modern developments of current-consuming appliances and their use is greatly in excess of that incident to the actual sale of apparatus to the farmer, who is the first to grasp the fact that the electrical era in the home is now here, and not a future possibility.

Cooking and heating by electricity is not only feasible, but an accomplished fact, and its growth depends on the activity of the central station in providing the necessary transmission wires and co-operating with the farmer in providing a stock from which he may have his choice, realizing that "the farmer is the one indispensible man. His industry is the industry of society. The real and fundamental prosperity of any state is rooted in the soil."

ELECTRICAL PUMPING AND IRRIGATION

RETAINING WALLS FOR CANALS.

BY B. A. ETCHEVERRY.

(Continued.)

Tunnel No. 2, 308.7 ft. long, did not require timbering as it was a compact red rock without seams. The tunnel was lined with an average thickness of 8 in. of concrete. It required about 2 cu. yds. of concrete per lineal foot. The actual cost to the contractor for the tunnel was:

Tunnel.	Length.	Cost of driving and timbering.	Concreting cost per cubic yard.	Total cost per lineal ft.
1	901	25.63	1567 cu. yd. @ 7.165	38.086
2	308.7	16.45	619 cu. yd. @ 8.325	34.149
3	1515	23.76	2879 cu. yd. @ 6.596	36.299
4	213	26.02	320 cu. yd. @ 6.918	36.414
	2937.7	23.73	5385	7.086	36.561

This does not include cost of cement or extras nor contractors' profits. The cost of cement was approximately $2.55 per barrel, which, allowing 1 barrel of cement to 1 cu. yd. of concrete would bring the cost of concrete to $10 per cu. yd. or a total cost per lineal foot of $43.00.

Belle Fourche Project Tunnel Lining.

On the south canal of the Belle Fourche project a tunnel of the horseshoe type has been constructed. The length of this tunnel is 1306 ft. and it is designed to carry 320 second feet. Where necessary the tunnel is timbered and above the arch the entire space is completely filled with hard stone so placed and wedged that it will carry the load uniformly to the tunnel arch.

Forms of Concrete.

The forms used in lining are of a very good type and have been entirely satisfactory. The work was done by force account for about one-third of the lowest bid. The forms consist of frames made up of two I beams bent to the proper shape, connected together at the top with a wedge shape key block placed with a channel bolted to the beams and holding them the proper distance apart. The foot of the 1 beams rest on the footing course. The frames are spaced 4 ft. apart center to center. On these frames rest the lagging 8 ft. long and built up of 1 in. lumber to conform to the shape of the tunnel and in widths of 20 to 24 in. and strongly braced. This lagging can be put on or taken off in section. The I beam frames can be taken

apart and moved ahead without disturbing the forms of the new work. In this manner the work can be carried on continuously. Many of the forms commonly used for tunnels or siphons can not be handled in this way.

The concrete used was a mixture of 1:2½:5. The length of the tunnel was 1306 feet. The actual quantity of concrete placed in the lining was 1.595 cu. yds. Under the requirements of the specifications, had the contract been awarded, payment would have been allowed for 1712 cu. yds. The accuracy of the excavation work reduced the quantity. The sand and gravel for the concrete were obtained at one end of the tunnel from natural beds and the concrete was mixed at this point. The wages paid were $2.30 per 8-hour day. The cost of construction exclusive of charges for survey and designs is as given below. The units costs given are based on 1712 cu. yds.; the unit cost based on actual number of cu. yds. is about 8 per cent greater.

Distribution of Cost.	Total Cost.	Cost per cu. yd.
Preparation expense	$ 731.30	$0.43
Plant depreciation	725.73	.42
Superintendence	318.00	.42
Superintendence	318.00	.81
Camp maintenance	430.03	.25
Cement	4,544.11	2.65
Lumber and steel forms	861.08	.50
Miscellaneous materials	45.20	.03
Fuel	105.14	.06
Lighting	81.43	.05
Miscellaneous supplies	230.80	.14
Hauling cement	1,624.25	.95
Hauling gravel and sand	432.32	.25
Crushing and screening gravel and sand	205.17	.12
Mixing and placing concrete	1,565.71	.92
Hauling forms	106.95	.06
Labor on forms and runways	890.61	.52
Blacksmith	137.19	.08
Finishing	373.02	.22
Miscellaneous labor	611.74	.36
Administration	878.25	.51
Engineering	633.07	.37
	$15,531.10	$9.07

HEADWORKS—WEIRS.

The parts of the headworks of a gravity irrigation system usually consist of diversion weir, canal headgates, scouring sluices and spillway or wasteway, and in some cases a fish ladder and logway.

The main object of a diversion weir is to raise the level of the water in the river when the supply is low and force it to flow through the headgates of the canal. A diversion weir is not always necessary. It may be more economical to continue the diversion line to a point where it will take the water at stream level. This usually requires a minimum flow in the river in excess of the desired canal supply.

The height of weir for any definite site depends on the depth of water in the canal, on the elevation of the floor of the canal and on the effect on lands above the weir. A high weir may, especially during the flood flow, cause either an overflowing of the river and damage land above the weir, or may change the channel of the river. This may be prevented by training or protection works to confine the river in its channel, or may require an open weir or a low weir with collapsable crest to allow flood flow to pass on with the least obstruction.

The length of weir depends upon velocity and volume of stream flow. Where a stream has high velocity and large flood flow, if several weir sites are available, it may be advisable to select the site where the length is not too small, for a short weir would necessitate a much heavier and stronger section than a weir of greater length. The decreased cost of the lighter section may offset the increased cost of a longer weir. A short weir requires a greater depth of water on the crest, which may cause the overflowing of land upstream, and is also subject to greater forces.

On the other hand, where a stream has a slow velocity and carries considerable sand and silt, it is preferable to restrict the weir to as short a length as feasible in order to obtain a higher velocity and prevent the deposition of silt, which in some cases may form islands above the weir. These islands may cause considerable trouble in diverting the channel of the river from the headgates. As a rule it is preferable to use the weir site giving the shortest weir.

The position of weir is generally at right angles to direction of flow. A skew weir has a tendency to cause currents parallel to the weir axis, which, on soft foundation, may result disastrously. A skew weir should only be used on very firm foundation.

Location of Weir.

A. Determination of location.

1. By topographical survey of entire country, using, when available, the U. S. G. S. maps.

2. By leveling from highest point of land to be irrigated, allowing proper grade for necessary length of canal, till the grade line intersects the stream or point of diversion.

3. By leveling from suitable point on stream to highest point of land to be irrigated, introducing drops or falls for excessive grade.

B. Conditions favorable to a good site for headworks.

When several sites are available the most favorable is that:—

1. Where there is room for construction of canal headgates and diversion line without the necessity of expensive construction, such as tunnel work, retaining walls, deep cut, etc.

2. Where the canal headgates can be placed at right angles to weir so as to keep a clear channel in front of the gates.

3. Near suitable building material.

4. Where good foundation and permanent banks can be obtained.

5. Where impervious stratum is at or near surface.

6. Where slope of stream is steep enough so that canal and stream shall be at the same level only for a short distance.

7. Where expensive high dam will not be needed to divert the water. It may be more economical to construct longer diversion line.

8. Where construction of weir will not cause flooding of lands above or tend to change the stream channel.

9. Where an escape can be constructed for scouring out material accumulating in upper part of canal.

10. Where velocity in stream shall be preferably less than the velocity in the canal which is desirable to prevent silt deposits in the canals. This can be largely regulated by the design of headgates.

11. Where channel is straight with uniform velocity and regular cross section. If on curved channel, when velocity is small, place headgate on outside of curve; when velocity is great, place on inside of curve where it will be safe from erosion. This especially applies to sites where no diversion weir is necessary.

C. Types of location.

The location of a weir site will be at one of the following points on the stream:

1. Junction of plains and foothill.
2. In plain or valley.
3. In the hills.

(1). When the weir is located on the stream where it emerges from the hills, at the junction of plains and foothill, the following conditions are generally encountered. The surface topography will be fairly smooth, the soil firm, and there will be few drainage crossings. These conditions would be favorable to an inexpensive diversion line. The sub-surface will usually be satisfactory for good foundations. It generally consists of gravel and boulders which in some cases overlay solid rock.

(2). When the weir site is on the valley portion of the stream the surface topography is usually smooth and fairly level and the stream has a flat grade. The sub-surface conditions are usually a stream bed of sand or clay; when sand and gravel it is necessary to prevent underflow under the dam. The conditions are favorable to a short and inexpensive line and to a low but long diversion weir. The disadvantages are (a) that the stream may not have sufficient fall to permit an easy diversion, (b) that there is danger of submerging land above the weir and of the stream cutting a new channel, (c) on streams with wide sandy beds, islands tend to form above weir and may cause parallel currents. These effects are largely prevented by using either an open weir on a closed weir with removable crest.

(3). When the weir site is in the hills the surface topography is rough, the slopes of side hills are steep, and the grade of the river large. The sub-surface conditions are generally a solid rock or boulder stream bed. These conditions usually require a strong weir in a narrow gorge and difficult and expensive construction of headworks and diversion line, with frequent cross drainage works, flumes, siphons, culverts, etc.

Causes of Failures.

The failures of weirs are generally due to one or more of the following causes:

A. Breaching by force of current.
1. Impact of falling water on floor of weirs which have a vertical drop.
2. Impact of trees and ice.
3. Erosion or scouring of downstream face of weir.
4. Erosion of river bed below weir and undermining.

B. Blowing up of weir by upward pressure on the under side of the impervious downstream floor.

C. Undermining of foundation by underflow.

D. Outflanking, especially where banks are friable and stream not straight. May be prevented by training works.

E. Parallel currents on upstream side of weir caused by islands formed above weir or caused by the weir being built on an angle with the direction of flow. To prevent formation of islands and the rise of the bed of the river caused by advancing sand, gravel or boulders, restrict length of weir, use open weir or provide collapsable shutters on closed weir. To prevent parallel currents on wide streams, buttresses or groins can be built at right angles to weir.

Diversion Weir, Modesto-Turlock Irrigation System.

NEW TELEPHONE SERVICE FOR CHINESE PORT.

The project of establishing a telephone system in Swatow, is again actively engaging the attention of local capitalists.

It is planned to open with a small exchange of about 100 subscribers, and it is not expected that there will be over 250 subscribers altogether in Swatow at any time. The concession was granted last October, and certain English and German manufacturers sent agents to study local conditions and submit estimates.

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POWER AND GAS

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Put it up to the Regulating Commissions

The telephone utility, a child of this generation, has so interwoven itself with the needs and daily life of the human race, argue against its ultimate good effect upon mankind if you will, nevertheless it is here to stay. Who knows but that Gabriel's last trump may be sounded by wireless telephony—so universal may be the ultimate application of this utility.

Incident in the affairs of life many unwarranted attacks are at times made upon those wholly blameless to the charges preferred. Wander at random, however in the cities of the West and perchance endeavor to use the telephone. In some cities immediate service is the result, while in others one can scarcely refrain from notes of plaintive memory: "I've waited, central, waited long for you." Again, in certain cities telephone rates appear from the surface absolutely incommensurate with the service rendered. Not only is this true, but the segregated parts of the charges certainly make up an inharmonious whole, difficult of explanation, at least to the layman's reasoning powers.

Take, for instance, the intercommunicating system, furnished by the Bell Telephone Company to its patrons. Here is a simple piece of apparatus, which any clear-thinking mechanic will tell you can be manufactured in bulk for a couple of dollars apiece, yet the patron is asked to pay annually six dollars for the box and six dollars for the telephone extension. It cannot be argued that this additional equipment causes unpaid for annoyance or extra work in operation of the main lines, for the company again provides an additional charge for calls over and above a minimum allowance. It is generally known in business circles that the executives of one of the largest jobbing houses on the coast recently desired to install this system in their new quarters for their own private use, but upon being told that they could not purchase an outfit for even $10,000 and that the annual rental would be $600 per year, went to an independent competitor and satisfied their wants by purchasing a complete equipment for $500.

Such wanton acts as this mildewing in the public mind, make the path of the utility company anything but a bed of roses, even though that company is endeavoring to be square and upright as a whole. Why, then, should the sore canker longer? If the telephone service is below par as thousands of citizens say it is, then an immediate remedy should be demanded? If the public is being held up unjustly in the charges forced upon them, or if any one of these charges bear an undue weight to the whole as is asserted on all sides, surely the regulating commissions have the authority and should use their strong right arm in adjusting the matter for all time to come. On the other hand, if these charges are not true the utility company should receive the cordial support and commendation of enlightened public sentiment, thereby acquired.

No one can meet the executives of the great telephone company on the coast without becoming impressed with their clean, clear cut mannerisms. Among their engineering staff are to be found men not only of intensified technical attainment but men of the highest ethical standing. Some eminent authorities have

argued that the human race is possessed of two consciences—the individual and the mob, that although separately an act would not be done, yet collectively the mob conscience becomes hardened. Such a belief is indeed the blackest and most deadening philosophy that one can entertain. Here, however, is a wide sweeping cry raised by the people on one hand, pittted in angry defamation against a group of honorable, highly sensitive business men, operating what may now be termed a human necessity. If all parties to this issue do want to do the square and upright thing, which as individuals no one doubts, but that they would do, then let them show down. Let them not only in a passive manner suffer impartial investigation and adjustment, but let them actually satisfy the public of their sincerity by openly courting such procedure.

Accidents, the How and Why

The past year, when reviewed in memory's fast fading shadows, stands ghost-like in its warning to inventory takers at this season of the year. The Titanic and its horrors beckon to the executive heads of transportation companies and others who have the directing of gigantic tasks wherein human lives are at stake, that they reckon not alone the physical inventory which leads to the determination of dividends and profits but also call a full stop and cast a balance sheet to determine the possible accidents that may occur and methods of their prevention. Especially should those directing Western enterprises heed this cry from the past.

Review for a moment some of the horrifying accidents of recent years. The General Slocum on the Hudson was heart-rending in its closing scenes, the Titanic and even the Rio de Janeiro attempting to enter the Golden Gate, were but typical scenes that might have happened to hundreds of other ships provided the combination of circumstances equally formidable presented themselves. But the next day—ah the next day—as the Good Book states: "Even the fool is wise after the event." Bearing in mind these awful catastrophes of the past, would it not be better to do away with some of the "I-told-you-so" talk and get busy in ferreting out possible chances that are perhaps even now being undertaken unawares in Western enterprises.

The spirit of the day in engineering is to step the voltage up to loftier limits, to build the dam to sublimer heights to concentrate more power in smaller shells and above all to outdo the competitor in his efforts. There is something inborn in us all, which calls for sincere admiration for this spirit of the West—that spirit which leads men to do and to dare, and above all to make good. Engineering enterprises, however, like the well-known laws governing materials of construction, have their elastic limit, beyond which a permanent set is bound to occur and disaster follow. True it is that brains and imagination may extend this limit from time to time but in the extension of this working range, we should build and build well or beware the crash.

Dangers often exist around us but the all necessary combination of circumstances, due to the low probability of occurrence of the individual events making up the whole, is so great its delay in coming is deceptive. Simply because, in throwing dice, the ace does not show itself in three trys is no argument that a one spot will not come in due time. Indeed, severe mathematical proof has established with certainty that, although one may throw three dice, in an endeavor to make an ace appear on each one, and fail two hundred and fifteen times, yet in the long run this will occur every two hundred and sixteen throws. So positive is the law of chance, mathematicians have established the ratio of the diameter of a circle to its circumference simply by counting the number of times straws would by chance drop through a grilled circle after a long series of trials.

It behooves all, then, to look well to the seldom but sure appearing of a combination of circumstances leading to disaster. The citing of but one instance will suffice. In the metropolitan district of Central California, thousands of commuters travel each day back and forth on ferry boats and electrified interurbans designed in accordance with the best and last word from invention. Certain of these boats have become so heavily patronized that between the hours of five and six, more passengers are taken than seats will accommodate. The seldom happening event is here possible to occur—the sudden bump, the excited crowd with no room to move to the decks or outer portions, the heart-rending shudder, the awful gurgling seconds immediately follows, and the floundering, helpless cries. Oh horrors—in such catastrophe—a passenger would have as much chance as a five ampere fuse wire short-circuiting a hundred thousand volt transmission line.

Now is the time for enlightened public sentiment combined with the best available engineering skill to check up such possibilities as these, which illustrates only one of the many that may perchance occur in the busy West.

Condensers for Lightning Protection

In the installation of lightning protective equipment it must be admitted that by doing away with the spark gap installation the consequent high series resistance in the ground connection becomes at once unnecessary. A non-inductive direct connection to ground cannot, however, be made on a high tension alternating current overhead transmission line without disastrous results. On the other hand a path to ground may be provided either through a highly inductive choke coil, or through a condenser, or through both. The inductive resistance may be easily designed to pass only inappreciable current of the normal or higher frequency, and it will therefore be useless as a means of relieving the line of a static charge. The condenser, however, acts as an almost perfect insulator so far as direct currents are concerned; but it is pervious to high frequency currents. A suitably designed condenser, or battery of condensers connecting between line and ground without the intervention of any spark gap is ideal in its handling of very high frequency oscillations that accompany lightning phenomena. The possible advantages of using condensers, provided the cost of these is not prohibitive far outbalance the objections. Such installations have apparently met with much favor in other parts of the globe, and there seems no reason why they should not prove equally effective on this continent and especially in the West.

PERSONALS

ITEMS FOR THIS DEPARTMENT ARE SOLICITED FROM ALL READERS

S. K. Colby, vice-president Pierson-Roeding Company, left this week for an extended trip east.

F. S. Hurst, of Pierson-Roeding & Company, recently returned from the south, where he went to spend the holidays.

H. L. Aller has succeeded **R. C. Whitmarsh**, resigned, as manager of the Pacific Gas & Electric Company at Phoenix, Ariz.

Herbert Haas, mechanical engineer, presented a paper on the Diesel engine at the meeting of the San Francisco Engineers' Club on January 7th.

H. S. Clark, Pacific Coast representative of Westinghouse, Church, Kerr Company, left last Saturday for an extended trip throughout the north and east.

G. B. Harrington, assistant general superintendent of the Puget Sound Traction, Power & Light Company, has returned to Seattle, after spending a month in the east.

J. A. Vandegrift, manager of the Oakland warehouse, National Quality Division of the General Electric Company, left during the past week for a trip throughout the East.

F. W. Hild, general manager of the Portland Railway, Light & Power Company, of Portland, Ore., is at Los Angeles and expects to be in San Francisco again January 16.

N. W. Brockett, secretary of the Northwestern Electric Light & Power Association, has sent out notices that the next meeting of the association will be held at Seattle, Wash., September 10, 11, 12, 1913.

Russ Holabird, of the Holabird-Reynolds Company, expects to leave the latter part of the week for the east, visiting his New England agencies, Chicago and other eastern cities, returning home about the first part of February.

J. R. Townsend of Portland, manufacturer of the Townsend pole top switch and representative of the Lord Manufacturing Company, the Electrical Engineers Equipment Company, and Stave arc lamps, is visiting San Francisco.

P. T. Hanscom has become assistant to the president of the Great Western Power Company, his duties as general superintendent being assigned to **E. W. Beardsley**, who has acted in a similar capacity for the Oakland, Antioch & Eastern Railway.

S. B. Charters Jr., assistant professor of electrical engineering at Stanford University, and at one time chairman of the San Francisco Section A. I. E. E., died on December 29th at Pittsburgh, Pa. All who have been associated with Professor Charters in the past will deeply feel the passing of his kindly personality.

A. E. Barlow, general sales manager for the American Ever Ready Company, called a Pacific Coast sales meeting at San Francisco this week. Those in attendance included **Roy Worth, C. E. Johnson, A. G. Bowes**, and **G. A. Koch** of the San Francisco office, **F. W. Kitson** of Spokane, **J. W. Leighton** and **R. R. Ruddiman** of Seattle, **F. T. Chapman** of Portland and **U. S. Johnson, C. T. Turner**, and **R. H. Marshall** of Los Angeles.

W. N. Ryerson, chairman of the Hydroelectric and Transmission Section of the National Electric Light Association, has appointed a number of Pacific members, including **P. M. Downing** of the Pacific Gas & Electric Company at San Francisco, who will act as chairman of the committee on distributing lines; the other Western members being **Markham Cheever** of Utah and **J. A. Lighthipe** of Los Angeles and **E. A. West** of Portland, and **C. L. Cory** of San Francisco, on the committee on receiving apparatus.

R. H. Ober was elected president of the Pacific Northwest Society of Engineers at the annual meeting held at Seattle on January 4. **Marvin Chase** was elected first vice-president; **Joseph Jacobs**, second vice-president; **Sterling B. Hill**, third vice-president; **Jesse A. Jackson**, secretary; **W. N. Chase**, treasurer, and **C. E. Hill**, librarian. Addresses were made by Superior Judge R. B. Albertson on the "Expert Witness." G. R. Conway of Vancouver, B. C., chief engineer and acting manager of the B. C. Railway Company, on "The Influence of Architecture on Modern Engineering"; Samuel Hill on "Good Roads," and Capt. Powell, the retiring president. The society now has a membership of 221.

J. G. WHITE & COMPANY'S RE-ORGANIZATION.

J. G. White & Company, Inc., of New York City, who for the past four years have maintained an office in San Francisco, announce the consummation of their plan to organize their engineering and construction and management departments into separate corporations.

Henry A. Lardner, who has been manager of the San Francisco office of the company, becomes a vice-president of the engineering corporation, but will continue his residence here in charge of Pacific Coast affairs. and Charles F. Conn, who has for some years been associated with the New York and San Francisco offices, will also remain in San Francisco.

The officers of the J. G. White Engineering Corporation are as follows: J. G. White, chairman finance committee; Gano Dunn, president; E. G. Williams, vice-president; A. S. Crane. vice-president; H. A. Lardner, vice-president; H. S. Collette, secretary; R. B. Marchant, treasurer.

Among the prominent California projects with which J. G. White & Company has been identified are: The construction of the Oakland & Antioch Railway and its associate, the Oakland, Antioch & Eastern Railway, now building between Oakland and Sacramento, a distance of 84 miles; the construction of a natural gas pipe line, 124 miles long and 12 inches in diameter, for the Midway Gas Company, which line is noteworthy because of its length and because it is to operate at a pressure of 450 pounds per square inch, the highest yet employed; the design and construction of storage reservoir and power plants, both hydraulic and steam, for the San Joaquin Light & Power Corporation, including the new 5000 h.p. development on the Tule River. Hydroelectric developments with which this company has been identified in other sections of the country include: Those on Big Sandy River, in Oregon; the Deerfield, an important tributary of the Connecticut River; the Savannah, near Augusta, Georgia; the Broad, near Columbia, South Carolina; the Ocoee, in the mountains of Eastern Tennessee, and the St. Lawrence, near Montreal, Canada. The aggregate capacity of these water powers is approximately 366,000 horsepower.

The J. G. White Management Corporation announce as officers: J. H. Pardee, president; F. H. Reed, vice-president; S. L. Selden, vice-president; T. W. Moffatt, secretary and treasurer.

The business of the Management Company was established some years ago as a department to supervise the operation of properties in which J. G. White & Company, Inc., was interested. This department, which has now been incorporated into a separate company, was, on December 31, 1912, acting as operating or consulting manager of public utility and railroad properties in the United States, Nicaragua, and the Philippine Islands.

The parent organization of J. G. White & Company, Incorporated, controls the new companies and will continue as an active financing and owning company.

COOPERATION BETWEEN THE PORTLAND RAILWAY, LIGHT & POWER CO. AND THE CITY INSPECTION DEPARTMENT.

In the future, all new electrical work in the city of Portland must be passed by the city electrical department before the Portland Railway, Light & Power Company, will supply service to same.

All orders the company receives for service are reported to the city department, who checks same over and passes or approves same for service. This is a great assistance to the city department and also insures better service for the consumers of electrical energy.

To further the interests of all parties concerned all the inspection departments (underwriters', city, and power company's) meet every two weeks and talk over all points of difference and settle upon methods of bettering conditions electrical. "Co-operation" is the motto and great results are accomplished.

NEWS OF CALIFORNIA RAILROAD COMMISSION.

Dec. 28.

The Torrance Water, Light & Power Company of Torrance, Los Angeles County, applied to the Railroad Commission for authority to issue 200,000 shares of capital stock (par value $1) for construction purposes.

The Great Western Power Company withdrew its application of December 23 and filed a complaint that the Pacific Gas & Electric Company and the Pacific Telephone & Telegraph Company be compelled to allow the Great Western Power Company to use their poles in Suisun upon the payment of a proportionate cost. The town of Suisun joined in the complaint.

The Southern Sierras Power Company applied for authority to raise certain rates for electric power service for pumping for irrigation purposes in portions of Riverside and San Bernardino counties.

A decision was rendered denying the application of the Roseville Home Telephone Company, of Roseville, Placer county, to raise the rental charge on farmers' lines from 25 cents to 50 cents per month.

A decision was rendered granting permission to the Southwestern Home Telephone Company, of Redlands, to advance the monthly charge for telephone service from San Jacinto to Winchester, Riverside county, from $1 to $1.50 per month.

A decision was rendered granting permission to the Coast Counties Gas & Electric Company to purchase the property of the Gilroy Gas Works for $25,000.

A decision was rendered denying the application of the Eel River & Southern Telephone Company, of Ferndale, Humboldt county, to establish a new schedule of rates.

A decision was rendered granting the application of W. H. Hoffett & Son, of Lemon Cove, to increase the rate on its Lemon Cove telephone lines to 50 cents per month.

A decision was rendered denying the application of the Raymond Telephone Company, of Raymond, Madera county, to increase rates between Raymond and The Pines, via Coarse Gold and Fresno Flats. The commission found the accounts of the company intermingled with those of a mercantile enterprise and directed that the telephone company segregate its accounts so as to present a proper financial statement within six months.

Dec. 31.

The San Diego Consolidated Gas & Electric Company applied for permission to issue $500,000 of six per cent debenture bonds.

A decision was rendered in the case of the town of Willits vs. the Willits Water & Power Company. The commission upheld the contentions of the city of Willits in its complaint of discriminatory rates in favor of big consumers and against the general public. An order was issued establishing a general decrease of 12 per cent for individual domestic consumers and certain increase for large consumers.

A decision was rendered granting permission to E. W. Crosby, doing business under the name of the Reedley Telephone Company, to establish a farmers' line rate of $3.60 per year as against a former rate of $3. The company was denied authority to raise its exchange rates.

A decision was rendered granting permission to the City Electric Company of San Francisco to issue $833,000 of bonds to be used as collateral security for loans to be made by the corporation.

Jan. 2.

A decision was rendered granting the application for a transfer of a franchise from Russel-Robison to the Russel-Robison Water & Electric Company, of Arroyo Grande, San Luis Obispo county.

A decision was rendered reducing the maximum lighting rates of the Northern California Power Company from 10 cents per kilowatt hour to 7 cents, or approximately 30 per cent in Colusa and Glenn counties; from 9 cents to 7 cents, or 22 per cent in Shasta and Tehama counties; from 8 cents to 7 cents, or about 12½ per cent, in Butte county. The reductions become effective on January 10. The decision also calls for a material reduction in power rates throughout the northern part of the state.

The Oro Electric Corporation applied for a certificate of public convenience and necessity to enter and serve the city of Stockton.

The Pacific Electric Company applied or authority to issue refunding mortgage 50-year gold bonds in the sum of $7,034,000. The proceeds will be devoted to improvements covering the principal lines of the company in Southern California and to the construction of new lines in the southern part of the state.

OREGON TECHNICAL CLUB.

The Oregon Society of Engineers and Portland Architectural Club have united their organizations in a parent association, styled the Oregon Technical Club. The purpose of this procedure is to afford a means by which club quarters may be maintained for all members of technical and professional societies that have obtained membership in the parent association. A Board of Governors, elected from each membership constitute the officers and manage the affairs of the club. Those elected to serve the first term are: J. A. Fouilhaux, Frank Logan, W. D. Holford, Paul Schuchart, H. L. Vorse.

BOOK REVIEW.

Elements of Western Water Law. By A. E. Chandler: size 6x9 in.; 150 pages; cloth binding. Published by the Technical Publishing Company of San Francisco, and for sale at the Technical Book Shop, 106 Rialto Building, San Francisco. Price $2.00.

The writings of Professor Chandler need little introduction to the readers of the Journal of Electricity, Power & Gas. This book is a compilation of a remarkable series of articles on western water rights which appeared in the columns of the Journal during 1912. Mr. Chandler, the well-known irrigation and water right specialist, has produced within the covers of this book, a compendium of western water rights, written in the clear, concise language of the polished engineer, and given to his profession, a hand book of information indispensable to Western engineers. The author covers in logical procedure a treatment of water right procedure in all the Western states, calling attention to good and bad features in vogue in the various commonwealths. The concluding chapter, being a desideratum in legislation regarding the public waters, is a splendid equipment for the practicing engineer. A thorough index is appended wherein is found alphabetically recorded subjects relative to water right procedure for the different states of the West.

THE ELECTRICAL CONTRACTORS' DEPARTMENT

COSTS AND EFFICIENCY.[1]

BY P. L. PROCTER.

The pleasure derived from meeting men depends greatly on the class of men met. When I sum up the achievements of the electrical contractors I cannot but feel that the pleasure is "all mine." Civilizers of the civilized is a term which I think is adaptable to you, for you represent a profession which, although remarkable at the present time, is yet, as we are told, in its infancy.

The subject I have taken for my address is one with which you are more or less familiar, but it is my purpose to explain to you details from an accountant's view. I shall endeavor to confine my theories so as to make them applicable specifically to the needs of the electrical contractor. It is well to forget, however, at this time that "The electrical contractors' business is different." While the details may change, the principles of costs and efficiency remain the same, no matter to which business they are applied.

The principles of costs as related to the electrical contractor, or any other contractor, are material, time, direct expense and indirect expense. The total of these plus profit is the amount a contractor must estimate in order to assure himself of his legitimate profit.

In order to arrive at a complete understanding of a business, introduce a scheme of accounts for ascertaining and recording the cost of production, locate all weak places and so detect waste of material, efficient workmanship and management. Indicate the expediency of underbidding a competitor by comparing the cost of production with his bid; establish a standard cost on certain jobs; expedite the framing of estimates to prevent loss by making low quotations, or unnecessary high ones, which will permit a competitor to underbid; regulate bidding price according to cost, when conditions of supply and demand permit. These features must necessarily be embraced in a cost system to be beneficial.

Now let us examine such a scheme to see in what way it would benefit you.

(1)—Where external conditions permit you will be able to adjust bidding price on the basis of costs.

Many a contractor feels that he is ruining his business by not grasping every job that comes along. He never stops to consider where his profit is to be realized, but the sight of a few dollars, or the anticipation, goes to his head. Business conducted in this manner results in the inevitable transfer to the "has been" list. The unbusinesslike principles of this one man does not only affect him as an individual, but it affects the whole trade as a body. Profit can be made on all work, but if one contractor makes a practice of underbidding, the consequences are that other contractors must patiently wait until the bankruptcy law begins to stretch out its arms for him. If "John Smith" makes an estimate on a job which you know you cannot compete with, you had better let him take it. Either he will go out of business or your own business needs rigid investigation.

(2)—It automatically locates weak places and points out excessive cost.

A feature which is indispensable. There are weak places in every business, and the only way to eliminate these weak points is by first assuring yourself in what department they prevail and in what unit of that department.

(3)—It furnishes a basis of comparing costs of various elements at different periods of time, indicating excessive increase of cost or decrease in output.

Knowledge of a business is attained by comparison. The fact that you had lost money on an estimate, but made money on a prior duplicate of it is sufficient grounds for an investigation. The investigation must be a comparative one. The material used on the subsequent estimate may have been more expensive, the labor employed may not be as efficient, the management may be at fault, but by the introduction of a comparative cost scheme these elements would be obvious before an estimate is made, and not when it is too late.

(4)—Shows the exact point where attention should be focused.

(5)—Where external conditions fix estimates you will know exact cost of production and be able to secure advantageous contracts which may otherwise go to a competitor.

It is often necessary for a contractor to reduce his estimate to the minimum because of external conditions over which he has no control. It is also often necessary, or considered business policy, for a contractor to reduce his estimate practically to cost of production in order to become acquainted with various architects with the idea that it may in some future time secure for him advantageous contracts. It is essential at such a time for him to know where the line of danger lies, and to know definitely his cost of production.

(6)—It determines the earning capacity of individuals, departments, branches or entire organizations.

By the old methods of accounting it was possible only to determine at stock-taking the amount of profit or loss of the entire organization. Competition makes it necessary for the business man of today to go further than this. The public designates the price for a certain class of work, and this has forced the business man to look elsewhere for profit. The only available place is the cost of production. It is essential, then, that he know the relative earning capacity of his men as individuals or the departments of his business.

(7)—It indicates the expediency of underbidding any competitor.

I have before mentioned that the contractor must know where to draw the line in underbidding, and not rush headlong into any contract. Money has strong hypnotic powers, and unless a business man uses his discretion he is gradually drawn into the maelstrom of failure by it. A man who has no system to his business usually is also devoid of discretion.

(8)—It furnishes a basis of protection from undue expense or loss from any source.

This is again brought about by comparison. "Undue expense" may be inefficiency in workmen, careless work, which necessitates it being done over again. This may be traced to the foreman, who has urged too much speed. This may again be traced to the executive who has given such instructions to the foreman. Low estimates often make it necessary for an executive to urge his men to better speed in order to avert a loss for which he alone is responsible. It will be seen that it is possible to trace the trouble to its foundation, therefore overcoming the most difficult obstacle in the way of eliminating it.

(9)—It shows how and when to reduce unnecessary fixed charges, such as time, material, men, records, interruptions, overtime, handling, etc.

In order to facilitate arriving at the costs on any job, particular attention should be paid to the manner of recording estimates. An estimate should be divided into departments in exactly the same manner that the cost records record the progress of a job by departments

(To be continued.)

[1]Address delivered before the Convention of Oregon Electrical Contractors' Association by Manager of the Pacific Audit Company, December 17, 1912.

NEWS NOTES

INCORPORATIONS.

SPOKANE, WASH.—Inland Independent Telephone System; $15,000; L. B. Cornell, Geo. R. Boomer.

ILLUMINATION.

BERKELEY, CAL.—The Pacific Gas & Electric Company will soon lay gas mains in Thousand Oaks.

SELIGMAN, ARIZ.—The Santa Fe Company plans to install an electric light plant here at a cost of $7550.

HERMISTON, ORE.—The Hermiston Light & Power Company has been granted a franchise to furnish lights for Echo.

YUBA CITY, CAL.—The election to organize a lighting district for the town of Live Oak carried, the vote being about two to one in favor of the same.

CHINO, CAL.—The Southern California Edison Company has been granted a franchise to construct and maintain a gas system in the public streets of Chino.

WELLS, NEV.—H. H. Cazier and his father, John H. Cazier, have been granted their application to appropriate the waters of Trout Creek for power purposes.

LOS ANGELES, CAL.—The installation of a system for street lighting in Garden district is recommended by H. R. Manahan, city electrician, in a report to the board of public works.

STOCKTON, CAL.—The Oro Electric Corporation has applied to the Railroad Commission or a certificate of public convenience and necessity to enter and serve the city of Stockton.

ELSINORE, CAL.—The Southern Sierra Power Company has applied for a 50-year franchise for transmitting electrical power in all public streets, said franchise will be sold February 10.

YREKA, CAL.—The California-Oregon Power Company is canvassing the ranchers living between its substation in Scott Valley and Callahan, a distance of 14 miles, to see if enough subscribers to take light and power can be secured to justify the building of a line.

ASTORIA, ORE.—Plans are being made by the Pacific Power & Light Company to reconstruct its gas plant in this city. The pipes are to be changed over and new purifying apparatus, new boilers, scrubbers and wash boxes will be installed.

PORTLAND, ORE.—The city executive board has adopted a resolution granting the petitions of property owners for street lights in all sections of the city. They will be installed by the Portland Railway, Light & Power Company, which will be paid a rental of $56 a year for each light, in accordance with the provisions of its present contract with the city.

SACRAMENTO, CAL.—A decision has been handed down by the Railroad Commission making a substantial cut in the rates charged by the Northern California Power Company. This decision follows closely upon the action recently taken by the commission which resulted in general reductions in lighting rates throughout Southern California. By the terms of its ruling in the Northern California Power case the commission reduces the maximum lighting rate in Colusa and Glenn counties from 10c per kw.-hr. to 7c, or approximately 30 per cent; from 9c to 7c, or 22 per cent in Shasta and Tehama counties, and from 8c to 7c, or about 12½ per cent, in Butte county.

STOCKTON, CAL.—At the meeting of the City Council only one bid, that of the Western States Gas & Electric Company, was received for street lighting during 1913, and the contract was awarded to that company. Arc lights will be furnished at $6 per light per month, to burn on an all-night schedule, and for electroliers the all-night schedule for five lamps will be $40 per year per electrolier. For five lights till midnight and one from midnight till day the rate will be $25 per year. Both electrolier prices are with the understanding that the company will not provide for their maintenance or for new lights and globes. The company will accept that work for $10 per year per lamp additional.

TRANSMISSION.

CORVALLIS, ORE.—The Oregon Electric Railway Company will build a branch from the main line to this city. Work will be started shortly.

VICTORIA, B. C.—Residents of Sydney have petitioned the British Columbia Electric Railway Company to extend their system to that city.

SEATTLE, WASH.—All bids submitted for furnishing 12 cars for the municipal railway and electrical equipment for same have been rejected as too high. Same will be re-advertised at once.

BEND, ORE.—The Central Oregon Power Company has been granted a franchise to construct power lines along the highways of Crook county. Kempster B. Miller was also granted permission to string telephone wires.

HOOD RIVER, ORE.—Construction of a 7000 h.p. hydroelectric plant intended eventually to supply power to operate an electric railway through Hood River valley will be started here by the Pacific Power & Light Company, the first of the year.

MOUNT VERNON, WASH.—The Stone & Webster Engineering Corporation is remodeling the old Mt. Vernon Interurban Railway Company's building on Main street, converting the same into a depot. Plastering, partitions, etc., are included in improvements.

TACOMA, WASH.—President John A. Shackleford of the Tacoma Railway & Power Company, is authority for the statement that the company will apply for a franchise to operate across the new Eleventh street bridge to tidelands, the mill and factory district of the city.

PORTLAND, ORE.—If deal for property located in Albina avenue, between River and Loring streets, being negotiated by the Northwestern Electric Company is consummated satisfactorily, a concrete or brick auxiliary power station will be built by the company at the location named.

HOOD RIVER, ORE.—Announcement has been made by officials of the Pacific Power & Light Company that Hood River will have the largest electric power plant in the state. The proposed plant to be built will develop between 7000 and 8000 h.p. It is also reported that the Pacific Power & Light Company will take over the Hydroelectric Company here.

LOS ANGELES, CAL.—The Southern California Edison Company, the Pacific Light & Power Corporation, and the Los Angeles Gas & Electric Company, have offered to take over power developed from the aqueduct from 35,000 h.p. upward, and have offered $1,000,000 per year for water power. The Council and Public Service Commissioners have the matter under consideration.

CENTRALIA, WASH.—To generate power from the falls on Coal Creek, eight miles west of Kelso, and to use the same in the operation of pumping plants within the Mount Solo diking district, is the plan of the commissioner of diking district No. 1. Steps have already been taken toward the locating of a power site on the river, and the commissioners expect to begin generating electric power as soon as possible.

VANCOUVER, WASH.—The Northwestern Electric Company has asked for a franchise to supply light, power and street car service in this city. The company asks for a 50-year franchise. The proposition was laid over until the next meeting of the city council.

RENO, NEV.—The Nevada Valley Power Company having a power site on the Truckee River at the Largamarsino bridge, and having other power sites in the mountains near Reno, has filed a $3,000,000 trust deed with the county recorder here, intending to bond its property for this amount to secure money to build its power plants. It intends to run in competition with the Truckee River General Electric Company. The company, in addition to its power sites, owns land and a number of rights of way. The trustee for this company is the International Trust Company of Denver. The directors are: H. D. Danforth, a local attorney; Edson Adams, Edward Bowes, Milton Hamilton and A. F. Tarley, all of Oakland.

REDDING, CAL.—The Redding Land Office has received notice that by an executive order of December 1 the government withdrew from entry 559 acres on McCloud River and 3038 on the Sacramento north of Copley, and reserved the acreage, "for water power sites, as Power Site Reserves No, 324 and No. 325." respectively, subject to the limitations, provisions, exemptions and conditions contained in the Act of Congress, approved June 25, 1910. The notice is accompanied by a detailed description of the land by sub-divisions. The land withdrawn includes every possible power site on the Sacramento from Conley north to Cantara, between Dunsmuir and Sisson. On the McCloud the sites withdrawn lie directly east of Sims and Antler, respectively. One site withdrawn is on Squaw Creek, a tributary of the McCloud.

REDDING, CAL.—The Northern California Power Company will spend $225,000 in Shasta county this year on improvements and betterments. The construction outlined is building the Dry Burney Creek storage reservoir, the greatest conservation project in the State, doubling the capacity of the power plant at Kilarc, or increasing it from 4000 to 8000 h.p., and doubling the power output of the South Cow Creek power plant. The Dry Burney Creek reservoir and 8250 foot tunnel in connection therewith will cost $130,000, as nearly as can be estimated. The enlargement of the Kilarc plant will cost $35,000, and the enlargement on South Cow Creek will cost the rest of the money appropriated. The Dry Burney Creek storage reservoir will be three and a half miles long and two and a half miles wide, with a shore line of nine miles. The average depth of the water will be 19 ft. The reservoir will hold 30,000 acre-feet of water—nearly a billion gallons—and after it has been utilized fo rgenerating power it will be available for irrigating 10,000 acres of Cow Creek Valley, as fertile land as lies within Shasta county's borders.

TRANSPORTATION.

SACRAMENTO, CAL.—The officials of the Central California Traction Company have moved the general offices of the company to Stockton.

VANCOUVER, B. C.—The British Columbia Electric Railway Company has awarded the contract for furnishing 65 city cars to cost approximately $500,000, to the Preston Car & Coach Company, Preston, Ontario.

TACOMA, WASH.—The Hillside Improvement Club has appointed a committee to confer with officials of the Tacoma Railway & Power Company relative to establishing a car line up Seventeenth street as far as Sprague.

EUGENE, ORE.—Plans for a new depot to be built here by the Oregon Electric Railway Company may be seen at the office of M. J. Duryea, Eugene Commercial Club. It is understood bids for material and construction will be received shortly.

TILLAMOOK, ORE.—It is rumored here that the United Railway Company will build an electric line from Banks to this place. The purchase of a 22,000 acre timber tract by the Tillamook Timber & Logging Company necessitates the proposed improvement.

EDMONTON, ALTA.—Inspector Moir's plan to build a belt system of 110 miles of electric railway lines in this city has been adopted by the city council. About 220 cars will be required. Commissioner Chalmers announces that at least 18 miles of track will be laid in 1913.

SEATTLE, WASH.—The following plans and specifications for materials to be used in the construction of the city municipal railway have been filed with the Board of Public Works. The switchboard and apparatus for the substation, motor generator set, two 500 kw. poles, stubs, etc.

SANTA BARBARA, CAL.—J. C. Breckenridge of Brooklyn, N. Y., who is to rebuild the Santa Barbara street railway system, has arrived in the city and it is expected that plans for construction will be decided upon at once. Mr. Breckenridge was manager and chief engineer for the Brooklyn Rapid Transit Company, and he will devote his entire attention to the reconstruction of this system.

OAKLAND, CAL.—Permission has been granted the San Francisco-Oakland Terminal Railway by the City Council to run a construction line on a private right of way between Forty-first and Forty-second streets, from the Key Route pier to the proposed tunnel on the road to San Jose. The line will be used for the hauling of rock and dirt from the excavation to the pier, which is to be made into a solid fill.

EL PASO, TEXAS.—The Rio Grande Valley Traction Company, which is the name of the new interurban line, will spend more than $300,000 in El Paso and the valley within the next eight months. C. W. Kellogg, general manager of the railway company, is in El Paso to complete the final arrangements for the details of line construction. The Stone & Webster Engineering Corporation has been given the contract for the entire work, and bids will be asked from local contractors for grading and right-of-way work, which will be sublet.

TELEPHONE AND TELEGRAPH.

ALBANY, ORE.—J. B. Coffey, receiver for the Northwestern Long Distance Telephone Company, has petitioned the circuit court to allow him to complete arrangements for a joint telephone line from Albany south to other Linn county points with the Home Telephone Company.

VANCOUVER, B. C.—The British Columbia Telephone Company received word of the complete destruction of the company's exchange at Abbotsford. The loss to the telephone company in the way of switchboard and equipment will amount to about $4000, and the value of the frame building will add $2000 to the loss.

TAFT, CAL.—The Standard Oil Company is preparing to connect its Lost Hills, Belridge and Midway field properties with a private telephone line similar to that now in use in the Midway fields. Materials are now arriving for the system and many of the poles have been distributed between McKittrick and the Lost Hills leases. The line when completed will be more than 50 miles long, having connection with nearly 30 miles of laterals in the Midway fields. It will be one of the longest private lines in the oil fields district.

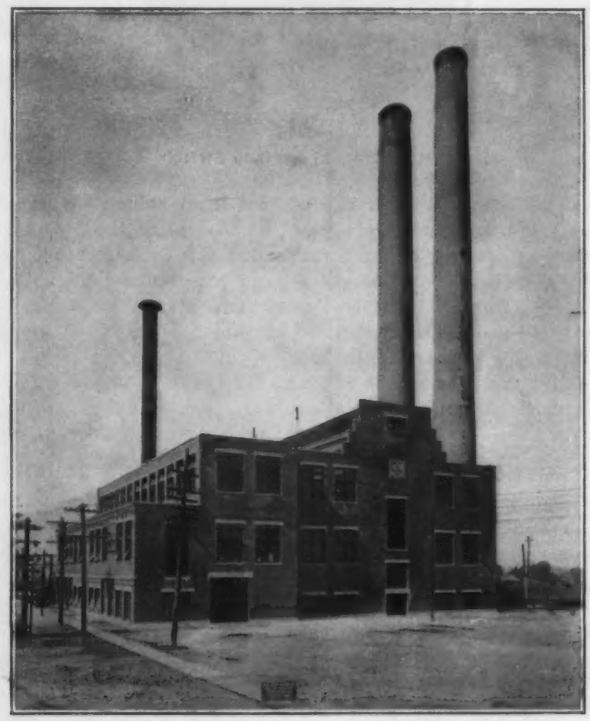
SAN FRANCISCO, CAL.—The Pacific Telephone & Telegraph Company has retired $5,000,000 two-year 5 per cent notes from the proceeds of the $12,350,000 preferred stock which was sold to the American Telephone & Telegraph Company shortly before the California public utility act went into effect. Of the $32,000,000 six per cent cumulative preferred stock authorized, the American owns $21,727,000, including this $12,350,000. The $750,000 Sunset Telephone & Telegraph first 6s, due July 1, 1913, will be taken care of by the sinking fund.

INDUSTRIAL

UTAH LIGHT & RAILWAY COMPANY'S PLANT AT SALT LAKE CITY, UTAH.

An instance of extremely rapid power plant construction has recently come to light in connection with the extension to the Jordan steam station of the Utah Light & Railway Company at Salt Lake City by Westinghouse, Church, Kerr & Co., constructing engineers, of New York City.

The original station was designed and built by the same engineers in 1910, and consisted of an 8500 kw. single unit steam turbine station, designed to act as an adjunct to various hydroelectric plants operating in the vicinity, and also to form the nucleus for such steam-generating equipment as might be later required to serve Salt Lake City. The operating conditions covering the original plant were as follows:



Utah Light & Railway Co's Plant, Salt Lake City, Utah.

In the Boiler Room of the Power Plant.

First—Wyoming coal to be used, carrying about 11,700 B.t.u. per pound.

Second—Ample condensing water, but unsuitable for boiler feed.

Third—Feed water to be purchased at comparatively low cost.

Fourth—Operation not continuous at first.

The new work, which consists of an extension to the old station, comprises in general a brick and steel building approximately 100 x 60 ft. The building walls rest on a pile concrete mattress composed of 36 ft. piles, overlaid with about 3 ft. of concrete. Condenser intake and overflow flumes are formed in the foundations.

The boiler room consists of a steel frame structure, supporting overhead coal bunker, with brick walls, concrete slab floors and roof. The turbine room is similarly constructed, the only steel, however, being in the crane rails, floor beams and roof trusses.

The boiler equipment consists of six Stirling boilers and Roney mechanical stokers, supplied with natural draft by means of a radial brick stack 11½ ft. in diameter by 228 ft. in height. The boilers operate at 200 pounds' pressure and 125 degrees superheat. Piping is thoroughly modern, designed with welded flanges for high pressure work and cast steel fittings and valve bodies. Valve seats, discs and spindles are of Monel metal, particular attention being given to providing for expansion and contraction in view of the high steam pressure and superheat.

In this station it was not necessary to store coal in large quantities, so the coal and ash-handling equipment is comparatively simple. It consists of a track hopper, into which coal is dumped from railroad cars, and carried by an inclined bucket conveyor up to the top of the boiler house, which it dicharges on a horizontal belt, by which it is distributed through the length of the bunker over the boilers. Ashes are dumped from ash jets into side dump cars, which run on an industrial railroad in the boiler room basement, are lifted to ground level by an elevator, and run out by hand to dump on adjacent land which is being filled.

Natural illumination of the boiler room is especially good. It is provided for by a system of skylights placed just beneath the coal bunkers. The photograph showing the boiler room interior was taken by natural daylight.

The turbine equipment consists of one Westinghouse-Parsons unit of 8500 kw. capacity, running at 3600 r.p.m., and delivering current at 60 cycles, 3 phases, 4400 volts. The unit is served by a Leblanc condenser placed directly beneath it in the turbine foundation, the condenser having turbine driven air and circulating pumps.

The main generator is provided with the usual air ducts for ventilation, and is excited by a turbine driven set of 100 kw. capacity. General Electric switching apparatus is contained in concrete cells, and the ring type of bus is used to secure the desired flexibility in switching operations.

The record of construction is given herewith:

March 27, 1912.—Authorization was received to design and build an extension to the original station, increasing its capacity 100 per cent.

April 1, 1912.—Five days after authorization sufficient progress had been made so that the main generator unit, the boilers, condenser, stack, heater, stokers and piles had been purchased. Inquiries for steel had been sent out and contracts were let for steel on April 3rd.

April 6, 1912.—Ten days after authorization the field organization arrived in Salt Lake and excavation was at once started. Construction office, storeroom and cement sheds were built.

In the Generating Room.

April 19, 1912.—Twenty-three days after authorization the first piles were received, and driving of same was begun, the stack foundations being finished on May 20th.

May 9, 1912.—Forty-three days after authorization stack brickwork was started, together with concrete foundation work. On May 19th brick building walls were begun. On May 21st boiler foundation piers were started, and on May 28th steel framing for boiler room floor was begun.

May 27, 1912.—Sixty-one days after authorization the boilers began to arrive, and sheet piling for condensing water intake and overflow flumes was started.

July 8, 1912.—One hundred and three days after authorization piping erection was commenced.

July 10, 1912.—One hundred and five days after authorization steam end of main generating unit arrived and was unloaded and put in position, condenser having been unloaded and placed about a week previously.

August 1, 1912.—One hundred and twenty-six days after authorization all structural work was finished, including brick walls, floors and roof, three boilers had been erected and tested, and five out of the six stokers erected.

August 6, 1912.—One hundred and thirty-one days after authorization main generator arrived and was placed on foundations; auxiliary work, wiring up and miscellaneous work went rapidly forward until August 26—152 days after authorization, the station was put under commercial load.

It is believed that this record has never been exceeded when the size of the station and its location is considered.

The work was designed and constructed by Westinghouse, Church, Kerr & Co., under the direction of Mr. O. A. Honnold, electrical engineer of the Utah Light & Railway Company.

CUTLER-HAMMER PUSH BUTTON SURFACE SWITCH.

The Cutler-Hammer Manufacturing Company has added to the rectangular base surface switches designed for moulding work a new type of circular base surface switch, which is made in two styles, No. 7107 having a label holder and

Push Button Surface Switch.

No. 7108 having a plain cap without label holder. Where a number of switches are located at one place the No. 7107 switch is adapted, as each may carry a label indicating the circuits or lamps controlled. A push bar, with a light button at one end and a black button at the other, does away with the usual protruding button, which may be broken off, or, by turning the wrong way, be removed and lost. The rating of the 7107 and 7108 switch is 5 amp. 125 volts, 3 amp. 250 volts (National Electrical Code Standard).

A THREE-HEAT CORD SWITCH FOR HEATING DEVICES.

There are many electric heating devices now on the market that are designed to operate at several "heats." Such devices as electric water urns, chafing dishes, heating pads, frying pans, table stoves, tailor's irons, etc., are advantageously operated at a low heat, medium heat and high heat. For the convenient control of these devices The Cutler-Hammer Manufacturing Company of Milwaukee has augmented its line of feed-through or cord switches by the addition of a three-heat brass shell type. This switch can be placed on the cord in the most convenient location for operation.

There are two push bars, each having a light and black button, which operate twin mechanisms so arranged that the pushing of one light button gives low heat, while the other, operated alone, gives medium heat. The shell is plainly marked, so that the operator may know which button to press for low and which for medium heat. To get high heat both are pushed. The operation is positive and snappy, and one hand only is needed for the manipulation of the push buttons.

NEW CATALOGUE.

Bulletin of "1913 Suggestions in Illuminating Glassware," from the Holophane works of General Electric Company, lists some 75 recent additions to the Fostoria lines of artistic glassware. The new styles cover a wide range of applications—hexagonal shades with cut or etched designs for shower fixtures, artistically designed globes for hanging units, Veluria portable lamps for the home, ice-etched shades in novel and popular designs for chandeliers or wall brackets, and Veluria hanging bowls for semi-indirect lighting.

JAN